# College of Engineering, Pune

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

## Department of Metallurgy and Materials Science

## 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 from the Academic Year 2015-16.

## 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 170 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 170 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. CIE and ESE shall have 40:60 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 4$^{th}$ Semester)
  - Host Department to float the courses from Honors-List as ONE in each Semester (viz. 5$^{th}$, 6$^{th}$, 7$^{th}$, 8$^{th}$ 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.

******

## Program Education Objectives (PEOs):

I. To prepare students to excel in postgraduate programs or to succeed in industry/technical profession through global and comprehensive education.

II. To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve engineering problems and also to pursue higher studies.

III. To train students with good scientific and engineering breadth so as to comprehend, analyze, design and create novel products and solutions for real life problems.

IV. To inculcate in students professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach and an ability to relate engineering issues to broader social context.

V. To prepare student with an academic environment aware of excellence, leadership, written ethical codes and guidelines and the life-long learning needed for a successful professional career.

## Program Outcomes (POs):

**The Undergraduate Students will demonstrate...**

1. Knowledge of basic sciences (i.e. Physics, chemistry, mathematics, biology etc.) to solve metallurgical and materials engineering issues.
2. Ability to design and conduct experiments, interpret and analyze data and report results.
3. Ability to perform experiments in metallurgy, characterization and proper materials selection.
4. Ability to function in engineering and science laboratory teams as well as on multidisciplinary projects.
5. Ability to identify, formulate and solve metallurgy and materials science problems.
6. Understanding of their professional and ethical responsibilities.
7. Ability to communicate effectively in both verbal and written form.
8. Confidence to apply engineering solutions in global and societal context.
9. Capability of self – education and lifelong learning.
10. Awareness of project management and finance related issues.
11. Ability to use modern engineering software tools and equipments to analyze metallurgy and materials science problems.

## Correlation between the PEOs and the POs

| PO→ PEO↓ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I | ✓ | ✓ | ✓ | | ✓ | | ✓ | | | | |
| II | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | |
| III | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | |
| IV | | | | ✓ | ✓ | | | | | ✓ | ✓ |
| V | | | | | | | ✓ | | ✓ | ✓ | ✓ |

**Note:** The cells filled in with ✓ indicate the fulfilment/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 Equation and Multivariate Calculus | 2 | 1 | 0 | 3 |
| 2 | BSC | Mechanical Technology | 3 | 0 | 0 | 3 |
| 3 | SBC | Materials Testing Laboratory | 0 | 0 | 2 | 1 |
| 4 | PCC | Structure & Properties of Materials | 2 | 1 | 0 | 3 |
| 5 | PCC | Principles of Physical Metallurgy | 3 | 0 | 0 | 3 |
| 6 | PCC | Introduction to Ceramics Engineering | 3 | 0 | 0 | 3 |
| 7 | PCC | Electrical & Instrumentation Technology | 3 | 0 | 0 | 3 |
| 8 | LC | Mechanical Technology Laboratory | 0 | 0 | 2 | 1 |
| 9 | LC | Principles of Physical Metallurgy Laboratory | 0 | 0 | 2 | 1 |
| 10 | LC | Electrical & Instrumentation Technology Laboratory | 0 | 0 | 2 | 1 |
| | | | 16 | 2 | 8 | |
| | | **Total Academic Engagement and Credits** | **26** | | | **22** |

**Semester IV**

| Sr. No. | Course Type | Course Name | Teaching Scheme | | | Credits |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1 | BSC | Vector Calculus and Partial Differential Equation | 2 | 1 | 0 | 3 |
| 2 | BSC | Science of Living Systems | 3 | 0 | 0 | 3 |
| 3 | MLC | Professional Ethics and Value Education | 1 | 0 | 0 | 0 |
| 4 | HSMC | Innovation | 1 | 0 | 0 | 1 |
| 5 | ILOE | Device Materials (For Other Departments) | 3 | 0 | 0 | 3 |
| 6 | SBC | Modern Chemical Analysis Laboratory | 0 | 0 | 2 | 1 |
| 7 | PCC | Fundamentals of Metal Working | 3 | 0 | 0 | 3 |
| 8 | PCC | Metallurgical Thermodynamics and Kinetics | 3 | 1 | 0 | 4 |
| 9 | PCC | Polymers and Composites | 3 | 0 | 0 | 3 |
| 10 | LC | Fundamentals of Metal Working Laboratory | 0 | 0 | 2 | 1 |
| 11 | LC | Polymers and Composites Laboratory | 0 | 0 | 2 | 1 |
| | | | 19 | 2 | 6 | |
| | | **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 | 0 | 5 |
| 2 | BSC | Mechanical Technology | 3 | 0 | 0 | 3 |
| 3 | BSC | Foundation of Physics | 3 | 0 | 0 | 3 |
| 3 | SBC | Mechanical Testing Laboratory | 0 | 0 | 2 | 1 |
| 4 | PCC | Structure & Properties of Materials | 2 | 1 | 0 | 3 |
| 5 | PCC | Principles of Physical Metallurgy | 3 | 0 | 0 | 3 |
| 6 | PCC | Introduction to Ceramics Engineering | 3 | 0 | 0 | 3 |
| 7 | PCC | Electrical & Instrumentation Technology | 3 | 0 | 0 | 3 |
| 8 | LC | Principles of Physical Metallurgy Laboratory | 0 | 0 | 2 | 1 |
| 9 | LC | Electrical & Instrumentation Technology Laboratory | 0 | 0 | 2 | 1 |
| 10 | LC | Mechanical Technology Laboratory | 0 | 0 | 2 | 1 |
| | | | 18 | 2 | 8 | |
| | | **Total Academic Engagement and Credits** | **28** | | | **24** |

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

| Sr. No. | Course Type | Course Name | Teaching Scheme | | | Credits |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1 | BSC | Multivariate Calculus and Differential Equations | 4 | 1 | 0 | 5 |
| 2 | BSC | Science of Living Systems | 3 | 0 | 0 | 3 |
| 3 | MLC | Professional Ethics and Value Education | 1 | 0 | 0 | 0 |
| 4 | HSMC | Innovation | 1 | 0 | 0 | 1 |
| 5 | ILOE | Device Materials (For Other Departments) | 3 | 0 | 0 | 3 |
| 6 | SBC | Modern Chemical Analysis Laboratory | 0 | 0 | 2 | 1 |
| 7 | PCC | Fundamentals of Metal Working | 3 | 0 | 0 | 3 |
| 8 | PCC | Metallurgical Thermodynamics and Kinetics | 3 | 1 | 0 | 4 |
| 9 | PCC | Polymers and Composites | 3 | 0 | 0 | 3 |
| 10 | LC | Fundamentals of Metal Working Laboratory | 0 | 0 | 2 | 1 |
| 11 | LC | Polymers and Composites Laboratory | 0 | 0 | 2 | 1 |
| | | | 21 | 2 | 6 | |
| | | **Total Academic Engagement and Credits** | **29** | | | **25** |

# Semester-III

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

**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, substitutions in multiple integrals, Applications to Area, Volume, Moments and Center of mass. **[11 Hrs]**

**Text Books**:

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

**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”, Thomson Brooks / Cole, Singapore, 7th edition
- Michael D. Greenberg," Advanced Engineering Mathematics," Pearson Education, 2nd Edition.

## (MA ) Linear Algebra and Univariate Calculus (Diploma Students)

**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)

**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. **[12Hrs]**

**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**:

- Maurice D. Weir, Joel Hass, Frank R. Giordano, "Thomas’ Calculus", Pearson Education, 12th Edition.
- Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley eastern Ltd., 10th Edition

**Reference Books**:


- Introduction to Linear Algebra (2nd edition) by Serge Lang, Springer.
- Elementary Linear Algebra (10th edition) by Howard Anton and Chris Rorres, John Wiley and sons.
- Calculus for Scientists and Engineers by K.D Joshi, CRC Press.
- A Course in Calculus and Real Analysis (1st edition) by Sudhir Ghorpade and Balmohan Limaye, Springer-Verlag, New York.
- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Advanced Engineering Mathematics (7th edition ) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Differential Calculus by Shanti Narayan, S. Chand and company, New Delhi.
- Applied Mathematics Vol. I (Reprint July 2014) by P.N. Wartikar and J.N. Wartikar, Pune Vidyarthi Griha Prakashan Pune.


## (MT 16001) Mechanical Technology

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

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

**Course Outcomes**

Students will be able to

1) Apply fundamentals of thermodynamics to various power producing and power absorbing devices
2) Understand basic principles of fluid mechanics and apply it to pumps
3) Understand basic modes of heat transfer and evaluate performance of heat exchangers

**Unit I :** Air standard Otto, Diesel cycles systems classifications of IC engines such as fuel supply system for SI & CI engines, ignition system, cooling system, lubrication system, Performance of IC Engine –Indicated power, Brake power, Thermal efficiency, Specific fuel consumption. **[08 Hrs]**

**Unit II:** Boilers: Classification, Essential of a good boiler, Mounting and accessories, Efficiency calculations, Steam turbines: Types, construction, Working, Compounding, Velocity diagram, Calculation of diagram efficiency **[08 Hrs]**

**Unit III:** Compressor: Uses of compressed air. Reciprocating compressors- effect of clearance, FAD calculation, efficiency calculation, multistaging, Rotary compressors-elementary treatment, Gas Turbine: Classification, Brayton cycle, thermal efficiency **[08 Hrs]**

**Unit IV:** Pumps: Rotary & reciprocating pumps,-construction & operation, pumps performance, and their selection, Water Turbine: Types, constructional details **[09 Hrs]**

**Unit V:** Machining basics, tool geometry, depth of cut, feed, speed, chip formation, machine tool

like lathe, turning, knurling, screw cutting, drilling, milling, planning, grinding machines, factors affecting machinability, coolants, non-conventional machining processes like EDM, ECM, water jet and ultrasonic cutting. **[09 Hrs]**

**Text Books**:

- R.K .Rajput, "Thermal Engineering", Laxmi Publications.
- Modi, Seth , Hydraulics And Hydraulics Machinary.
- R. K. Jain, "Engineering Metrology", Khanna Publisher, Delhi.
- Nakra Choudhary, "Instrumental Measurement and analysis", Tata McGraw Hill.
- D. S. Kumar, "Mechanical measurement and control", Metropolitan N Delhi.
- Chapman, „Workshop technology vol. I,II & III, Edward Arnold Publication Ltd. London
- Hajara Chaudhari S.K., „Workshop Technology, Vol. I & II", Media Prom & Publication, Mumbai.
- R. K. Jain, Production technology, Khanna Publications.

**Reference Books:**

- Y.A. Cengel, "Thermodynamics – an Engineering approach", Tata McGraw Hill.
- Eastop, Mc"conkey, "Applied Thermodynamics", Addison Wesley Longman Publishers.
- IS codes for vernier caliper, micrometers, slip gauges, angle gauges, limits, fits, tolerances, gauges, geometrical tests etc.
- Collette & Hope,²Engineering Measurement", ELBS publisher
- HMT Hand book- Production Technology
- P. C. Sharma, „ Production Engineering", Khanna Publications.

## (MT 16002) Structure and Properties of Materials

**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**

Students will be able to

1) Understand basic structure of engineering materials.
2) Understand theoretical basis of mechanical, electrical, magnetic, optical, thermal and dielectric properties.
3) Analyze, interpret and solve materials design problems.
4) Correlate structure of materials with their properties.

**Unit I:** Classification of engineering materials, levels of structure, structure- property relationships in materials, primary atomic bonds, secondary atomic and molecular bonds, ionic bonding, covalent bonding, metallic bonding, dipole bonding, bond strength quantification, variation in bonding character and properties **[07 Hrs]**

**Unit II:** Space lattice, metal structures, ceramic structures, polymeric structures, unit cells, crystallographic directions and planes, Millar indices , single crystals, polycrystalline materials, anisotropy , non crystalline solids , metallic crystal structures : FCC, BCC and HCP, atomic radius, linear and planar densities, close packed structures, polymorphism and allotropy, non crystalline structures - amorphous materials. **[07 Hrs]**

**Unit III:** Point , line , planar and volume imperfections , atomic vibrations, screw and edge dislocations, mixed dislocations, energy of dislocations, dislocation motion, micro plasticity of crystals, slip systems, critical resolved shear stress and schmid's law, twinning, Atomic model of elastic behavior, the modulus as a design parameter, rubber like elasticity, relaxation processes, spring- dash pot models. **[07 Hrs]**

**Unit IV:** Engineering and true stress strain diagrams, yield and tensile strength, compression and shear strength, ductility and brittleness, hardness, stiffness, resilience, toughness, fatigue and creep resistance, ductile and brittle fracture, transition temperature, Material testing standards, Non destructive testing. **[07 Hrs]**

**Unit V:** Resistivity range, the free electron theory, conduction by free electrons, energy gap in solids, super conducting phenomenon, magnetic moments due to electron spin, ferromagnetism and related phenomena, polarization and dielectric properties. **[07 Hrs]**

**Unit Vi:** Refractive index, reflectance, transparency, translucency and opacity, colour and luminescence, heat capacity, thermal expansion, thermal conductivity and thermal shock.

**[07 Hrs]**

**Text Books**:


- V. Raghvan, "Materials Science and Engineering", Prentice Hall of India Publishing 5th Edition,2006.
- Askeland & Phule, "Material Science & Engineering of materials" 4th Edition, 2003.
- W.D. Callister, "Materials Science and Engineering", 8th Edition, 2006.


**Reference Books**:


- W. F. Smith - Foundation of Materials Science and Engineering, Mc Graw-Hill International, 5th Edition, 2009, New York.
- S. O. Kasap - Principles of Electronic Materials and Devices, Tata McGraw-Hill Publication, 3rd Edition, 2006, New York.
- K. Schroder, Electronic Magnetic and Thermal properties of Solids, Marcel Dekker, 1st Edition, 1978, New York.

## (MT 16003) Principles of Physical Metallurgy

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

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

**Course Outcomes:**

Students will be able to:

1. Describe techniques used for quantitative metallography.
2. Draw the equilibrium diagram, identify the various phases and calculate the relative amounts of phases for binary and ternary alloy system.
3. Draw and label Iron -Iron carbide diagram and iron -Graphite phase diagram and define various phases associated with it.
4. Develop structure and properties correlation for various steels and cast irons.
5. Classify Copper base, Aluminum base, Magnesium base and Titanium base alloys and predict their microstructures

**Unit I:** Metallography: Specimen preparation for microscopic examination for different metals and alloys, electrolytic polishing, etching and mounting techniques, metallurgical microscope, Quantitative Metallography, volume fraction of phases by area, linear analysis, point counting methods for grain size and phase measurements, grain size significance and measurement, macroscopic examination methods, types of non metallic inclusions rating. **[07 hrs]**

**Unit II:** Solid Solutions and Phase diagrams: Solid solution and intermediate phases, Gibb's phase rule, phase equilibria, alloy phases and compounds, Cooling curves, Hume Rothery's rule of solid solution formation, Solidification, Binary equilibrium diagrams and related microstructures, Lever rule application, numerical for phase analysis, Non equilibrium cooling of alloys, Ternary diagrams-simple **[07 hrs]**

**Unit III:** Iron-Carbide system: Iron-Iron carbide equilibrium diagram, critical temperatures, plain carbon steels, slow cooling of steels and cooling curves, effect of impurities, property variation with microstructure, classification and specifications of steels.
Isothermal transformation diagrams: Plotting, Transformation to pearlite, bainite and martensite, Continuous cooling transformation diagram, Effect of carbon, grain size and alloying elements, importance of IT and CCT diagrams to heat treatment. **[07 Hrs]**

**Unit IV:** Cast Irons: Fe-Graphite diagram, Factors controlling microstructure, Types of cast irons :gray, White, malleable cast, Nodular, Chilled and Mottled cast iron, Step bar test, Alloy cast irons: Ni hard, Ni resist, Silal, Austempered ductile iron. **[07 Hrs]**

**Unit V:** Copper and Copper base Alloys: Phase diagrams of Cu based alloys : brasses, bronzes, Sn Bronzes, Si Bronzes, Al Bronzes, Be Bronzes, Microstructure, Properties and applications of various types of brasses and bronzes, Cupronickel and nickel silvers. **[07 Hrs]**

**Unit VI:** Light metal alloys: Classification and temper designation of aluminium alloys, precipitation hardening of Al-Cu system, Modification treatment of Al-Si system, classification, properties and applications: Magnesium & its alloys ,Titanium & its alloys. **[07 Hrs]**

**Text Books**:


- S. H. Avner, Introduction to Physical Metallurgy, Tata McGraw-Hill Education, 1997.
- Askeland & Phule, Material science & Engineering of materials,4th edition, Thomson Publication,2003.
- R. A. Higgins, Engineering Metallurgy: Applied Physical Metallurgy Volume -I, R.E. Krieger Publishing Company, 1983.
- Vijendra Singh, Physical Metallurgy, Standard Publishers Distributors, 2005.
- V. Raghvan, Physical Metallurgy, PHI learning Pvt. Ltd.,Second edition 2006.
- W.F.Smith, Principles of Material Science and Engineering, 2nd edition , McGraw-Hill Companies; 1990.


**Reference Books**:


- Robert E. Reed Hill, Physical Metallurgy Principles, 2nd edition, Van Nostrand, 1972.
- ASM Handbook Volume 9: Editor George F. Vander Voort, ASM International, 2004.
- ASM Handbook Volume 3: Alloy Phase diagram, ASM International, 1992.


## (MT 16004) Introduction to Ceramics Engineering

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

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

**Course Outcomes:**

Students will be able to:

1. Explain the importance of chemistry/stoichiometry, bonding, crystal structure and microstructure of ceramic materials in arriving at the final properties.
2. Select the appropriate ceramic processing techniques starting from powder making to fabrication the finished products.
3. Analyze and solve the problems related to ceramics engineering.
4. Comprehend microstructures of advanced ceramics.

5. Explain the important properties and applications of ceramics.

**Unit I:** Introduction to ceramics: definition of ceramics, Comparison of properties with metals and polymers, electronegativity, introductory band theory, important ceramics structures, coordination, ionic radii, Kroger Vink notation of point defects, defect reactions, density-theoretical and experimental density calculations, concept of energy well and its applications. **[07 Hrs]**

**Unit II:** Phase equilibria: Phase rule, one component system- displacive and reconstructive transformation, binary system - eutectic & incongruent melting, phase separation, solid solutions, free energy composition and temperature diagram, important thermodynamics and kinetic aspects. **[07 Hrs]**

**Unit III:** Ceramic powder processing methods: Ball milling, Chemical vapour deposition, Sol-gel, Polymer pyrolysis, Coprecipitation, Spray Drying/pyrolysis, DMO and RBAO. **[07 Hrs]**

**Unit IV:** Forming methods: Conventional compaction route (ceramics route) and Novel processing techniques to finished products - Slip and Tape casting, gel casting, CIP, HIPping, extrusion, injection moulding and spray forming. **[07 Hrs]**

**Unit V:** Sintering theory and microstructure development: Different mass transport mechanisms, Sintering parameters-Materials and Processing, Role of defects during sintering, Solid and liquid phase sintering, Grain growth and Ostwald ripening, pore-grain boundary interactions. **[07 Hrs]**

**Unit VI:** Important ceramics - properties and applications: Structural, Ionic conducting, Dielectric - ferroelectric and piezoelectric, Thermal (including furnace refractories), Magnetic and Optical ceramics. **[07 Hrs]**

**Text Books:**


- C. Barry Carter, M. Grant Norton, Ceramic Materials- Science and Engineering, Second Edition, Springer New York, 2013.
- M. N. Rahaman, Ceramic Processing and Sintering, 2nd edition, Marcel Dekker Inc., NY, 2003.
- W.D. Kingery, H.K. Bowen and D.R. Uhlman, Introduction to Ceramics, Ceramic Science and Technology, John Wiley and Sons, Singapore, 1991.


**Reference Books:**


- M.W. Barsoum, Fundamentals of Ceramics, 2nd edition, IoP Publications, UK, 2003
- C.J. Brinker, D.E.Clark, and D.R. Ulrich, Better Ceramics through Chemistry, North Holland, 1984.
- F.F.Y. Wang, Ceramic Fabrication Processes, Academic Press, 1976.
- J. Reed, Introduction to the Principles of Ceramic Processing, 2nd Ed., John Wiley & Sons. 1995.

## (MT 16005) Electrical and Instrumentation Technology

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

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

**Course Outcomes:**

Students will be able to:

1. Understand and explain construction and working of various types of generators and motors.
2. Select appropriate technique for heating/melting of metals and alloys.
3. Distinguish between various types of sensors and transducers.
4. Select appropriate sensor/transducer for a given application.

**Unit I:** DC Machines: DC Generator: Construction, generating action, emf equations, types of generators, and characteristics of generators, D.C motor: Motoring action, significance of back emf, types of dc motors, voltage and current relationships of different motors, torque equation, torque-speed characteristics, Different methods of starting (need of starter) different method of speed control, braking & applications. **[07 Hrs]**

**Unit II:** Induction Motor: Types, principle of operation, types, slip, power flow diagram, torque equation, condition of max. torque, torque slip characteristics, various methods of speed control, braking and applications, Single Phase Motors: Single phase induction motors, Special purpose motors- A.C. series motors, universal motors, Factor affecting choice of above motors for industrial applications like rolling mills, cranes, shear press, Mechanical press. **[07 Hrs]**

**Unit III:** Electrical Heating: Resistance Heating: Direct and Indirect methods, Stefan's law of radiation of heat, Material used and designing of heating element, efficiency and control equipment. Induction Heating: Construction, Working principle of induction furnace, High/ Low frequency generation, Core type furnace, Coreless type furnace, High frequency eddy current heating, Electric Arc Furnace: Types, Construction, Working principle, Power factor, Impedance, Heat Treatment Furnace Heating: Heating elements, Dimmer state, Voltmeter, Current measurement. Eddy Current and Dielectric Heating **[07 Hrs]**

**Unit IV:** Definitions: Transducer, Sensor, classification: Active, passive, primary, secondary, mechanical, electronic, analog and digital transducers, Characteristics: Static and Dynamic characteristics. Displacement Measurement: Overview, principle of operation &applications: Resistive: strain gauges. Inductive: LVDT, Capacitive: Capacitance pickups, Piezoelectric, Ultrasonic transducers and Hall effect transducers. Force: Basic methods of force measurement, elastic force traducers, strain gauge. **[07 Hrs]**

**Unit V:** Temperature Measurement: Overview, principle of operation &applications:

RTD, Thermistors, thermocouples, Semiconductor temperature sensors: Diode and IC temp sensors. Ultrasonic temp detector, Radiation: Pyrometers (Total and Selective), Infrared sensors. Flow Measurement: Overview, principle of operation &applications: Flow sensors: Orifice, Venturi and Nozzle.

Variable area meter, Rotameter, Turbine type flow meter, Electromagnetic flow type, ultrasonic flow meter. **[07 Hrs]**

**Unit VI:** Pressure measurement: Overview, principle of operation &applications, High-pressure sensors: Dead weight tester, Vacuum sensors McLeod gauge, thermal conductivity (Pirani, Thermocouple gage) ionization type. Level measurement: Float, displacers, bubbler, and DP- cell, Ultrasonic, data loggers Fundamentals of control system, Control actions: On-off, proportional, integral, derivative, electronic controllers, stability of system. **[07 Hrs]**

**Text Books:**

- Stephen J., Fundamental of Electrical Machinery.
- Nagrath & Kothari 2/e, Electrical Machines.
- Instrumentation Measurements and Analysis – B.C.Nakra and K.K.Choudhari
- Electronic Instruments & Measurement - A. K. Sawhney, Dhanpatrai publications, New Delhi
- Process Control Instrumentation Technology - C.D. Johnson, PHI (5th Edition).
- Analytical Instrumentation Handbook- R.S.Khandpur

**Reference Books:**

- Dr. P. S. Bhimra, Electrical Machines
- Little Richard, Welding Technology
- Rajan & Sharma, Heat Treatment & Furnaces
- Measurement Systems - E.O. Doebelin (4th Edition).
- Principle of industrial Instrumentation – Patranabis.
- Process Measurement & analysis - B.G. Liptak (Vol-I)
- Instrumentation Devices & system - Rangan Sarma
- Instrumentation and Measurement Principles – D.V.S. Murthi

## (MT 16006) Materials Testing Laboratory

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

**Examination Scheme :**
Continuous evaluation : 40 Marks
End-Sem Exam: 60 Marks

**Laboratory Outcomes:**

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

1. Perform tensile and compression test on universal testing machine and analyze the results obtained.
2. Select and perform appropriate hardness test for a given material.
3. Identify the situation under which impact testing would be needed and able to perform the test.
4. Perform torsion and bend tests.
5. Select the appropriate non destructive test and perform it.

**List of Experiments/Assignments:**

1. Study of universal testing machine: Principle and Construction.
2. Tensile Test: to conduct tensile test on standard of M.S./C.I. Plotting of stress- Strain curves and comparison of test results.
3. Study the effect of gauge length on percent % elongation.
4. Study of Hardness Testing Machines such as I) Brinell II ) Vickers III) Poldi.
5. Study of Rockwell /Rockwell superficial hardness testing machines and testing various materials with these machines using different loads and indenters (i.e. scales).
6. Study of microhardness and Shores Scleroscope techniques.
7. Compression Test on C.I. /Aluminium or Brass.
8. Study of the effect of L/D ratio on the compression test results.
9. Study of pendulum impact testing machine and conducting impact test on samples of various materials /with different notches and interpretation of results.
10. Torsion test on wire samples of mild steel/spring steel.
11. Bend test on steel plate and bar samples.
12. Study of dye penetrant, magnetic particles, eddy current, radiography, ultrasonic methods.

## (MT 16007) MECHANICAL TECHNOLOGY LABORATORY

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

**Examination Scheme :**
Continuous evaluation : 40 Marks
End-Sem Exam: 60 Marks

**Laboratory Outcomes:**

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

6. Identify and explain characteristics of carburetor, injector etc.
7. Calculate various parameters related petrol/diesel engine.
8. Perform various machining operations.
9. Measure surface roughness, angular, screw thread, profile projector measurements etc.

**List of Experiments/Assignments:**

1. Study of Solex carburettor & Bosch type fuel injector pump.
2. Test on Diesel/Petrol engine to determine BP, bsfc, Brake thermal efficiency.
3. Study of boiler mountings & accessories.
4. Trial on reciprocating air compressor.
5. Trial on centrifugal pump.
6. Machining on Lathe, milling machine and drilling machine.
7. Surface roughness, Angular, screw thread measurement (Any Two).
8. Interferometer, profile projector measurements (Any Two).

## (MT 16008) PRINCIPLE OF PHYSICAL METALLURGY LABORATORY

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

**Examination Scheme :**
Continuous Evaluation : 40 Marks
End-Sem Exam: 60 Marks

**Laboratory Outcomes:**
At the end of laboratory work, Students will demonstrate the ability to:

1. Prepare the samples for microscopic examination and understand the concepts of quantitative metallography.
2. Identify the microstructures of various ferrous and nonferrous alloys and develop structure and properties correlation for various applications.
3. Analyze the microstructures of different metals and alloys using optical microscopy and image analysis software for characterization

**List of Experiments :[Any 08 Experiments]**

1. Preparation of specimens for microscopic examination: steels, copper alloys and aluminium alloys, cast irons.
2. Preparation of specimen for microscopic examination by hot mounting and cold mounting methods.
3. Study of etching mechanism of single phase and two phase alloys and preparation of etching reagents for plain carbon steel, cast iron, copper base alloys and aluminium alloys.
4. Study of Metallurgical microscope.
5. Observation and drawing of different morphologies of grains: equiaxed dendrites, columnar dendrites, cellular structure, equiaxed grains, polygonal grains, elongated grains.
6. Grain size measurement by ASTM comparison method, Heyn's Intercept method, Jefferies planimetric method.
7. Observation of microstructures using image analyzer, Quantitative Metallography software, models and tools for grain size, shape, phases distribution and porosity.
8. Observation and description of microstructures of annealed plain carbon steels.
9. Observations and description of microstructures belonging to various cast irons.
10. Observations and description of microstructures belonging to various brasses, bronzes, wrought and cast aluminium alloys.
11. Student will bring unknown metallic sample; prepare it for metallographic observation; observe and describe the microstructure with identification of phases present in it.

## (MT 16009) ELECTRICAL AND INSTRUMENTATION TECHNOLOGY LABORATORY

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

**Examination Scheme :**
Continuous Evaluation : 40 Marks
End-Sem Exam: 60 Marks

**Laboratory Outcomes:**
At the end of laboratory work, Students will demonstrate the ability to:

1. Select and use the appropriate sensors for the measurement of parameters like temperature, pressure, flow etc.
2. Draw he characteristics of various types of generators.
3. Use the appropriate motors (single phase or three phase) for a given application.

List of Experiments :[Any 08 Experiments]

1. External & internal characteristics of a D.C. shunt generator.
2. A) Speed control of D.C. shunt machine by
   (i) Armature voltage control
   (ii) Field current control method
   B) Study of motor starters
   (i) 3 point starter
   (ii) 4 point starter
   (iii) 2 point starter
3. Load test on D.C Shunt motor.
4. Load test on 3ph and 1 ph Induction motor to determine its performance.
5. Study of induction motor starters.
6. Characterization of temperature measurement system (RTD, Thermocouple).
7. Characterization of flow measurement system (Orifice, Venturi).
8. Characterization of level measurement system (Capacitive, Bubbler).
9. Characterization of pressure measurement system (Load cell).

# Semester-IV

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

**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:** 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 ($12^{th}$ 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**:

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

## (MA ) Multivariate Calculus and Differential Equations (Diploma Students)

**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)

**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**:

- 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**:

- Calculus for Scientists and Engineers by K.D Joshi, CRC Press.
- A Course in Multivariate Calculus and Analysis by Sudhir Ghorpade and Balmohan Limaye, Springer Science and Business Media.

- Differential Equations with Applications and Historical notes by George Simmons, Tata Mc-Graw Hill publishing company Ltd, New Delhi.
- Functions of several variables by Wendell Fleming, Springer-Verlag, New York.
- Partial Differential Equations (4th edition) by Fritz John, Springer.
- Advanced Engineering Mathematics by C.R. Wylie, McGraw Hill Publications, New Delhi.
- Advanced Engineering Mathematics (7th edition ) by Peter V. O' Neil, Thomson.Brooks / Cole, Singapore.
- Advanced Engineering Mathematics (2nd edition) by Michael D. Greenberg, Pearson Education.


## (AS 16001) Science of Living System

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

**Examination Scheme**
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.

**Selected 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

## (ML 16001) Professional Ethics and Value Education

**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) Contribute to societal and human well – being.
2) Appreciate and deal with ethical dilemmas while discharging duties in professional life.
3) Appreciate the concept of gender diversity and related issues from an ethical viewpoint.

**Unit I:** Morals, Values and Ethics, Integrity, Work Ethic, Honesty ,Commitment, Courage, empathy, self – confidence, character, caring and sharing, empathy and leadership. **[02 Hrs]**

**Unit II:** Introduction to history of ethics, profession and professionalism, professional roles played by an engineer, engineering ethics (supported by case studies), moral/ethical dilemma, moral autonomy, consensus and controversy etc., codes of conduct and ethics, gender diversity at workplace, women's empowerment, sexual harassment. **[03 Hrs]**

**Unit III:** Types of technology and their ethical application, Transfer of technology, its benefits and drawbacks, Role of multinational corporations in technology transfer, Environmental ethics and need for sustainable development, Environmental hazards due to irresponsible technological development, Computer ethics and IPR, and computer crime **[02 Hrs]**

**Unit IV:** Meaning of experimentation in engineering, Engineers' role as responsible social experimenters to benefit society, R&D efforts towards ethically and environmentally sustainable design of products and systems, A balanced view towards legal, ethical and business aspects of technology use. **[02 Hrs]**

**Unit V:** Knowledge of safety and risk and the ethical need to reduce it, Uncertainty of design, Need for testing product and system designs for safety, Concept of risk benefit analysis, Ethical issues in cost-benefit analysis, Protecting employee rights, human rights and human responsibilities, Case studies involving natural and manmade disasters, (e.g. Chernobyl, Bhopal Gas Tragedy, floods in Uttarakhand, Kashmir, etc. **[02 Hrs]**

**Unit VI:** Meaning and brief history of whistle blowing, Internal and external whistle blowing, Ethical and legal issues involved in whistle blowing, Managing whistle blowing, Case studies involving whistle blowers like Manjunath, Satyendra Dubey, etc. **[03 Hrs]**

## (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 herself/himself.
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.

## (MT16014) FUNDAMENTALS OF METAL WORKING

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

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

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

1. Understand the mechanism of plastic deformation.
2. Classify metal forming processes.
3. Compile advantages and limitations of metal forming processes and evaluate the force required for deformation of material by various metal forming operations.
4. Compute stresses developed in component of different shapes under variety of loading condition.
5. Evaluate principle stresses in 2 Dimension and 3 Dimension state of stress.

**Unit I:** Classification of forming processes , cold, hot and warm working processes, Plastic deformation, flow curve metallurgical structure, friction and lubrication, hydrostatic pressure and workability, Forces and geometrical relations in rolling, Projected length of contact, Neutral point, Forward slip and backward slip, Rolling force and rolling load, Angle of contact and angle of friction, Material spread in rolling, Torque and horsepower in rolling, Problems and defects in rolled products. **[07 Hrs]**

**Unit II:** Forging, Classification of forging processes, Forging equipment, Forging in plane strain, Open and closed die forging, Calculations of forging loads in closed die forging, Significance of flow lines, Residual forces in forging, Forging defects, Drawing of rods wires and tubes, Analysis of tube drawing, Temperature increase in wire drawing, Die wear, Water-cooling of dies. Residual stresses in drawn products. **[07 Hrs]**

**Unit III:** Extrusion, Classification of extrusion processes, Extrusion equipment. Hot and Cold extrusion. Deformation and lubrication in extrusion, Analysis of extrusion process, Hydrostatic extrusion. Extrusion of tubing, Extrusion defects, Sheet metal forming and forming methods, Rubber forming, Shearing and blanking, Bending, Stretch forming, Deep drawing, Forming limit criteria, Defects in formed parts . **[07 Hrs]**

**Unit IV:** Types of loading in materials used in engineering, Basic ideas about stress, direct stress, and shear stress, Hooke's law for three dimensions, Stresses and strains in bodies under variety of loads and with varying dimensions, Thin cylinders under pressure, Hoop stress and longitudinal stress. **[07 Hrs]**

**Unit V:** Bending stresses in beams, Torsion of shafts and springs Concept and determination of two dimensional principal planes and principal stresses, maximum shear stress, Mohr's circle of stress- two dimensions, numerical problems based on analytical and Mohr's circle method. **[07 Hrs]**

**Unit VI:** System of a body under three dimensional stresses. Matrix representation of the state of stress under three dimensions, determination of principal stresses, principal planes and maximum shear stress for three dimensional state of stress, , Yielding criteria **[07 Hrs]**

**TEXT BOOKS:**

- George E. Dieter,Mechanical Metallurgy, SI Metric Edition,1988, McGraw-Hill Book Company.
- Ghosh A., Mallik A.K., Manufacturing Science, 1985, Affiliated East-West Press (P) Ltd., New Delhi.
- Serope kalpakjian, Steven R. Schmid, Manufacturing Engineering and Technology, International Edition, Fourth Edition, 2001, Prentice Hall International.
- Metal Forming Process, Nagpal G.R., First Edition, 2000, Khanna Publishers, New Delhi.

**REFERENCE BOOKS:**

- Mechanical Working of Metals, Harris J. N., 1983 Jan 01, Pergamon Press, Elmsford, NY.
- ASM Metals Handbook Vol. 14A:Metal Working :Bulk Forming, Materials Park, Ohio.
- Hosford W.F Caddell, Metal Forming Mechanics and Metallurgy, Prentice Hall, 1983.

## (MT 16010) Metallurgical Thermodynamics and Kinetics

**Teaching Scheme:**
Lectures : 3 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. Explain fundamental laws of thermodynamics
2. Calculate enthalpy, entropy, Free energy changes and thermodynamic properties for various metallurgical processes
3. Predict feasibility of reactions using chemical equilibrium constant
4. Apply phase rule and phase equilibrium criterion to predict phase stability at particular temperature and composition
5. Explain the electrochemical technique to measure thermodynamic quantities

**Unit I :** Thermodynamics systems, Classification, thermodynamic variables, State functions, Process variables, Extensive and intensive properties, Energy and first law of thermodynamics, Heat capacity, Enthalpy, Heat of reactions, Hess‟s law, Kirchhoff's equation, Thermochemistry **[09 Hrs]**

**Unit II :** Second law of thermodynamics, Entropy, Effect of temperature on entropy, Statistical nature of entropy, Combined statements of first and second law of thermodynamics, Gibb's free energy, Helmholtz's free energy, Maxwell's equations, Gibbs-Helmholtz equation, Clausius-Clapeyron"s equation and its application to phase changes, Free energy as criterion for equilibrium and its applications to metallurgical reactions, Third law of thermodynamics. **[10 Hrs]**

**Unit III :** Activity, Equilibrium constant, Le-Chatelier‟s principle, Chemical potential, Law of mass action, Effect of temperature and pressure on equilibrium constant, Vant Hoff‟s isotherm, Free energy-temperature diagrams, oxygen potential and oxygen dissociation pressure, Gibb‟s phase rule and its applications, Free energy composition diagram. **[09 Hrs]**

**Unit IV :** Solutions, Partial molar quantities, Ideal solutions, Raoult‟s law, Non ideal solutions, Gibbs-Duhem equation, Free energy of formation of solution, Regular solutions, application to phase equilibria, excess thermodynamic quantities. **[10 Hrs]**

**Unit V :** Electrochemical cell, Determination of thermodynamic quantities using reversible electrochemical cell, EMF cell, electrode potential, Electrode potential-pH diagrams and their applications. **[09 Hrs]**

**Unit VI :** Reaction kinetics: Arrhenius equation, order of reactions. [**09 Hrs]**

**Text Books**:


- D. R. Gaskell, "Introduction to Thermodynamics of Materials", McGraw Hill Book Co. Inc., III Edition, 1995.
- Ahindra Ghosh, "Text book of Materials & Metallurgical Thermodynamics", Prentice Hall India, 2009


**Reference Books**:


- L. S. Darken and R. W. Gurry, "Physical Chemistry of Metals", McGraw- Hill, 1953
- R. H. Parker, "An Introduction to Chemical Metallurgy", Pergamon Press, Inc., 1978.
- G. S. Upadhya and R. K. Dubey, "Problems in Metallurgical Thermodynamics and Kinetics", Pergamon Press, Inc., 1977.
- David V. Ragone, "Thermodynamics of Materials Volume I and II", John Wiley & Sons, Inc. 1995.

## (MT 16011) Polymers and Composites

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

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

**Course Outcomes**

Students will be able to

1) Explain basic structures of polymers, their properties and applications.
2) Select appropriate techniques for processing of polymers.
3) Distinguish between metal, ceramic and polymer matrix composites along with advantages and limitations of each of these.
4) Correlate the microstructure of composite materials to their properties.

**Unit I:** Polymers: Introduction, Classification of Polymers, Degree of Polymerization, Polymerization Reactions, Polymerization Mechanisms: Addition Polymerization, Copolymerization, Condensation Polymerization, Polymer Structures and Shapes, Cross Linking and Branching, Crystallinity and Stereo-Isomorphism in Polymers. **[07 Hrs]**

**Unit II:** General-Purpose Thermoplastics, Engineering Thermoplastics, Thermosetting Plastics (Thermoset), Elastomer (Rubbers), Structure-Property Relationship in Thermoplastics, Characteristics and Applications of Polymers, Processing of Plastic Materials: Processes Used for Thermoplastic and Thermosetting Materials. **[07 Hrs]**

**Unit III:** Deformation and Strengthening of Plastic Materials, Mechanical Properties: Creep and Fracture of Polymeric Materials, Visco-elasticity, Stress Relaxation, Glass Transition Temperature and Polymer Degradation **[07 Hrs]**

**Unit IV:** Composite Materials: Introduction, Reinforcements: Natural Fibers, Synthetic Fibers, Synthetic Organic and Inorganic Fibers, Particulate and Whiskers Reinforcements, Reinforcement-Matrix Interface. **[07 Hrs]**

**Unit V:** Particle Reinforced Composites: Large Particle Composites, Dispersion Strengthened Composites, Fiber Reinforced Composites: Influence of Fiber Length, Orientations and Concentrations, Fiber Phase, Matrix Phase, Processing of Fiber Reinforced Composites, Structural Composites, Rule of Mixture, Fracture Mechanics and Toughening Mechanisms **[07 Hrs]**

**Unit Vi:** Composites with Metallic Matrices: Introduction, Metal Matrix Composite Processing, Interface Reactions and Properties of MMCs, Polymer Matrix Composites: Introduction, Polymer Matrices, Processing of PMCs, Ceramic Matrix Composites: Introduction, Processing and Structure of Monolithic Materials, Processing of CMCs. **[07 Hrs]**

**Text Books**:


- V.R. Gowariker, N.V. Viswanathan, Jayadev Sreedhar, Polymer Science, New Age International (P) Limited Publishers, New Delhi, 1996.

- Premamoy Ghosh, Polymer Science and Technology of Plastics and Rubbers, Tata McGraw-Hill Publishing Company Limited, New Delhi,1990.
- F.L.Matthews, and R. D. Rawlings, Composite Materials, Engineering and Science, Woodhead Publishing Limited, Cambridge, England,1999.

**Reference Books**:

- Mel M. Schwartz (R), Composite Materials Handbook, Vol. II, Processing, fabrication and applications, 2nd Edition, McGraw-Hill, New York, 1992.
- K.K. Chawla, Composite Materials Science and Engg., 2nd Edition, Springer Verlag, 1998.
- D. R. Askland and P. P. Phule, The Science and Engineering of Materials, 4th Edition, Pacific Grove Publication, 2003.
- William F. Smith, Principles of Materials Science and Engineering, 3rd Edition, McGraw-Hill, 2002.
- William D. Callister, Jr, Materials Science and Engineering – An introduction, sixth edition, John Wiley & Sons, Inc. 2004.
- ASM Handbook, Vol. 21, ASM International, OH, USA.

## (MT 16012) Modern Chemical Analysis Laboratory

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

**Examination Scheme :**
Continuous evaluation : 40 Marks
End-Sem Exam: 60 Marks

**Laboratory Outcomes:**

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

1. Design and conduct elemental analysis experiments from different materials.
2. Perform contemporary analysis techniques like analysis of galvanized coating

**List of Experiments/Assignments: (Any 08 experiments)**

1. Estimation of carbon in steels by colorimeter.
2. Estimation of Fe from steel sample.
3. Estimation of Si in steels & cast iron
4. Estimation of Mn in steels & cast iron
5. Estimation of P in steels & cast iron
6. Estimation of Ni in steels & stainless steels
7. Estimation of Cr in steels & stainless steels
8. Estimation of Mo in steels & stainless steels
9. Estimation of Vanadium in alloy steel.
10. Estimation of Cu & Pb by Electro-gravimeter
11. Estimation of Carbon in steel and Cast iron by using Strohlien's apparatus
12. Estimation of Ni / Cu by Atomic Absorption Spectroscope
13. Study of FIVE Indian Standards related to chemical analysis of Elements.

## (MT 16015) FUNDAMENTALS OF METAL WORKING LABORATORY

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

**Examination Scheme :**
Continuous evaluation : 40 Marks
End-Sem Exam: 60 Marks

**Laboratory Outcomes:**

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

3. To perform various metal working operations such as rolling ,forging ,extrusion ,wire drawing, sheet metal forming and analyze the data.
4. To evaluate the effect of cold working and hot working on microstructure and mechanical properties of steel and copper base alloys
5. To correlate the structure property relationship associated with different metal working processes.
6. To solve numerical based on strength of materials ,plastic deformation and metal working processes.

**List of Experiments/Assignments: (Any 08 experiments)**

1. Assessment of non metallic inclusions in steels as per ASTM E 45.
2. Effect of cold rolling and process annealing on microstructure and mechanical properties of Copper base alloys ,Plain carbon steel and Stainless steel.
3. Effect of hot working on microstructure and mechanical properties of Copper base alloys ,Plain carbon steel and Stainless steel.
4. Study of open die and closed die forging processes. To perform open die forging of steel samples.
5. Observations of flow line pattern of forged part.
6. Study of rolling mills ,effect of rolling parameters on final product ,defects in rolled products and their remedial measures.
7. To study and perform sheet metal forming operations like deep drawing ,stretch forming, shearing ,blanking and bending.
8. To determine formability of sheet metal using cupping test.
9. Study of extrusion of aluminium and its alloys.
10. Numerical based on strength of material ,plastic deformation and metal working processes.

## (MT 16013) Polymers and Composites Laboratory

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

**Examination Scheme :**
Continuous evaluation : 40 Marks
End-Sem Exam: 60 Marks

**Laboratory Outcomes:**

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

1) Select appropriate process for processing of polymers.
2) Determine the mechanical properties of polymers and composites.
3) Calculate theoretical and experimental density of polymers and composites.
4) Evaluate electrical and thermal properties of polymers and composites.

**List of Experiments/Assignments: (Any 08 experiments):**

1. To Cast Thin Polymer Film Using Film Casting Method.
2. Fabrication of Composites by Injection Molding Process.
3. Fabrication of Composite Compacts by Hot Compaction Process.
4. To Measure Density of Composites by Archimedes's Principle.
5. Impact Properties of Polymer and Composites by Izod Impact Test.
6. To Measure Hardness of Polymers and Composites by Durometers and Micro hardness Tester.
7. To Measure Melt Flow Index (MFI) of Polymer and Composites.
8. Tensile Properties of Rubber, Polymers and Fiber Reinforced Composites.
9. Study of Optical Microstructure of Composites.
10. Study of Tribological Properties of Polymer Based Composites.
11. Characterization of Composites by XRD.
12. Characterization of Fractured Composites by SEM.
13. To study Vicat Softening Point Apparatus.
14. Numericals Based on rule of mixture and inverse rule of mixture.

## (ILOE) Device Materials

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

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

**Course Outcomes**

Students will be able to

1. Select and design a conducting material for a given application.
2. Understand the difference between intrinsic and extrinsic semiconductors.
3. Distinguish between various types of magnetic materials and select them for proper applications.
4. Understand the difference between piezoelectricity, Ferroelectricity and pyroelectricity.
5. Select various electronic materials for optical applications.

6. Understand the material requirements for solar cells, oxygen sensors and auxiliary applications like fuses, soldering materials, contact materials etc.

**Unit I:** Functional basis for materials selection, Device design and production, Resistivity range, Free electron theory, Conduction by free electrons, Temperature and Impurity effects, Conductor and resistor materials, Superconductivity and Meissner effect, Type I and Type II superconductors and their applications. **[07 Hrs]**

**Unit II:** Energy gap in solids, Mechanism of electrical conduction in intrinsic and extrinsic semiconductors, Effect of temperature on electrical conductivity of intrinsic and extrinsic semiconductors, Effect of doping on carrier concentration in extrinsic semiconductor, Hall effect Semiconductor materials, Materials for circuits, MOS structures Memories and IC fabrication. **[07 Hrs]**

**Unit III:** Dielectric constant and polarizability, Polarization mechanism, Frequency and Temperature effects, Electrical breakdown, Ferroelectric materials, Piezoelectricity, Capacitor dielectric materials, Insulating materials and Pyroelectric materials **[07 Hrs]**

**Unit IV:** Classification of magnetic materials, Magnetic moments due to electric spin, Ferromagnetism, anti ferromagnetism and ferrimagnetism, Magnetic energy and domain structure, Hysteresis loop, Soft and Hard magnetic materials, Magnetic recording materials, Bubbles, Thin films and Tapes, Discs and Magneto optics, Diluted Magnetic Semiconductor, Multiferroic materials **[07 Hrs]**

**Unit V:** Light and electromagnetic spectrum, absorption in semiconductors, Photoconduction, Luminescence, Materials for Displays, Semiconductor Laser and Optical fibers, Electro optic ceramics, Fluorescent and phosphorescent materials **[07 Hrs]**

**Unit Vi:** Materials for solar cells, Materials for oxygen sensors, Conducting Polymers, Soldering materials, Fuse and Contact materials, Thermocouple materials, Thermoelectric materials. **[07 Hrs]**

**Text Books**:


- W. F. Smith - Foundation of Materials Science and Engineering, Mc Graw-Hill International, 5th Edition, 2009, New York.
- N. Braithwaite and G. Weaver - Materials in Action Series -Electronic Materials, Butterworths Publication, 2nd Edition, 1990, Oxford.
- S. O. Kasap - Principles of Electronic Materials and Devices, Tata McGraw-Hill Publication, 3rd Edition, 2006, New York.


**Reference Books**:


5. K. Schroder, Electronic Magnetic and Thermal properties of Solids, Marcel Dekker, 1st

Edition, 1978, New York.
6. K.H.J. Buschow (Ed.), Handbook of Magnetic Materials, Elsevier 1st Edition, 1991, Amsterdam.
7. W. D. kingery, H. K. Bowen and D. R. Uhlman, Introduction to ceramics –2nd Edition, John Wiley and Sons, 1976, New York.
8. R.C. Buchanan – Ceramic materials for Electronics, Marcel Dekker, 3rd Edition, 2004, New York.
9. A.J. Moulson and J.M. Herbert, Electroceramics: Materials, Properties and Applications, John Wiley and Sons, 2nd Edition, 2003, West Sussex.

## (PH 16001) 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)

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