College of Engineering, Pune

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

Department of Metallurgy and Material Science

Curriculum Structure & Detailed Syllabus (UG Program)

Third Year B.Tech.

(Revision: A.Y. 2016-17, Effective from: A.Y. 2017-18)

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

1. No. of Semesters/ Year	Three; Two being Main Semesters (Odd and Even) and One being a Supplementary Semester; (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; Supplementary Semester: 8 Weeks;
3. Academic Activities (Weeks):	Main Semester (Odd or Even) Registration of Courses- 0.5; Course work- 15.5; Examination Preparation-1.0; Examinations- 1.0; Declaration of Results- 1.0; Total: 19; Supplementary Semester (only for make-up Courses): Registration of Courses- 0.1; Course Work- 7.0; Examination Preparation-0.2; Examinations- 0.2; Declaration of Results- 0.5; Total: 8; Inter-Semester Recess: After each Main Semester- 2; After Supplementary Semester- 2; Total: 14 (for good students) and 6 (for weak students) *(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).Committee (DUPC).*

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; (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; • Academic schedules prescribed shall be strictly adhered to by all the Departments; • Supplementary Semester shall be mainly for Make-up Courses, to benefit weak or failed students to the extent possible; • Students failed in a course shall attend a Course fully when it is offered again, and appear for all components of evaluation; • Specified Min. /Max. Course load per Semester shall be followed always.

(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. Wilful 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, homework 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 50 marks 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:

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

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:

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

where, m is the number of courses registered up to 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:

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.

(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.

20. Eligibility for the CGPA improvement after completion of prerequisite 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 result 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 5th Semester of UG program and applicant must have a minimum CGPA of 6.0 (up to 4th Semester).
  - Host Department to float a SINGLE course from Minor-List, ONE in EVERY Semester starting from 5th 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 an '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 5th Semester of UG program.
  - Applicant should have CGPA score of 6.0 (up to 4th Semester)
  - Host Department to float the courses from Honors-List as ONE in each Semester (viz. 5th, 6th, 7th, 8th Semester, of which preferably the SECOND course could be a MOOC from NPTEL / edX / Coursera / Udacity /Purdue Next / 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. Up to 8th Sem. Total: 08 Courses.
  - A Student opting for 'Honors' will NOT be ENTITLED to register for 'Minor'.
  - Allotment of SLOT in Time table on the line of ILOE (e.g. Mon-Wed: 9 to 10 am).
  - Department to identify and appoint a faculty member as 'Honors/Minor Coordinator' for guiding the aspirants.

- **Specific Remarks:**

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

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Program Education Objectives (PEOs):

The following are the PEOs set by the department...

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	No of courses	Credits	% of Credits	
BSC	Basic Science Course	12/13	30/33	18-20	Approx. 40-45 %
EFC	Engineering Foundation Course	9	22	13	
MLC	Mandatory Learning Course	4	0	0	
ILOE	Institute Level Open Elective Course	2	6	3.5	
SLC	Self Learning Course	1	3	2	
HSMC	Humanities/Social Sciences/Management Course	5/6	8/11	4.5 / 6.5	
LLC	Liberal Learning Course	1	1	1.18	
SBC	Skill Based Course	8	17/21	10 to 12.5	Approx. 55- 60 %
PCC	Program Core Course				
DEC	Department Elective Course				
LC	Laboratory Course				

Semester V [Metallurgical Engineering] THIRD YEAR ENGINEERING

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Transport Phenomena	3	1	0	4
2	MLC		Environmental Studies	1	0	0	0
3	HSMC/ ILOE		• English Language Proficiency-I • Finance for Engineers-I • Engineering Economics-I • Industrial Psychology-I • Personnel Psychology-I • Japanese Language-I • German Language-I	1	0	1	2
4	SBC		Heat Treatment Technology Laboratory	0	0	2	1
5	PCC		Heat Treatment Technology	3	0	0	3
6	PCC		Iron Making	3	0	0	3
7	PCC		Mineral Processing and Extractive Metallurgy	4	0	0	4
8	LC		Mineral Processing and Extractive Metallurgy Laboratory	0	0	2	1
9	DEC		Department Elective - I [Wire Drawing & Sheet Metal Forming / Non Destructive Testing/ Tribology of Materials]	3	0	0	3
10	HSMC		Entrepreneurship Development	1	0	0	1
			Total Academic Engagement and Credits	**25**			**22**

Semester VI [Metallurgical Engineering] THIRD YEAR ENGINEERING

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	MLC		Constitution of India	1	0	0	0
2	HSMC/ ILOE		• English Language Proficiency-II • Finance for Engineers-II • Engineering Economics-II • Industrial Psychology-II • Personnel Psychology-II • Japanese Language-II • German Language-II	2	0	0	2
3	SLC		Internship (min. 04 weeks)	0	0	4	2
4	SBC		Miniproject	0	0	4	2
5	SBC		Non Ferrous Metallurgy Laboratory	0	0	2	1
6	PCC		Foundry Technology	3	0	0	3
7	PCC		Structural Metallurgy	3	1	0	4
8	PCC		Steel Making	3	0	0	3
9	PCC		Materials Characterization	2	1	0	3

10	LC		Materials Characterization Laboratory	0	0	2	1
11	LC		Foundry Technology Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**30**			**22**

N.B: Students are required to undergo minimum of 4 weeks training in industry/research organization in any of the vacations by the start of 6th semester.

Courses for B.Tech Honors (Metallurgical Engineering)

Semester.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
V			Nanomaterials and Nanotechnology/Powder Metallurgy	3	0	0	3
VI			Mechanical Behavior of Materials/ Light Metals and Alloys	3	0	0	3
VII			Theory and Practice of Sintering / Phase Transformations	3	0	0	3
VIII			Amorphous materials / High Temperature Corrosion	3	0	0	3
			Total Academic Engagement and Credits	**12**			**12**

Courses for B.Tech Minor (Metallurgical Engineering)

Semester.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
V			Composite Materials	3	0	0	3
VI			Non Destructive Testing	3	0	0	3
VII			Bio-materials	3	0	0	3
VIII			Fracture and Failure of Engineering Materials	3	0	0	3
			Total Academic Engagement and Credits	**12**			**12**

Semester-V

Transport Phenomena

Teaching Scheme:
Lectures : 3 Hrs/week
Tutorial : 1 Hr/Week

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

Course Outcomes:
At the end of course students will be able to

1. Derive the mathematical equations based on the information provided for various momentum, heat and mass transfer conditions.
2. Distinguish between laminar and turbulent flow conditions and use appropriate equations to solve the numerical problems based on these conditions.
3. Analyze the conditions in the heat transfer problems and use appropriate equations to arrive at numerical solution.
4. Describe various laws of diffusion, reaction kinetics and mass transfer and solve the numerical problems based on these concepts.

Unit I: **[8 hrs]**
Types of fluid flow, Newtonian and non - Newtonian fluids, viscosity of liquid metals, slags and gases, Momentum balance, Flow of falling film, Fully developed flow between parallel plates, Equation of continuity and the momentum equation, Navier - Stoke's equation, Application of Navier - Stokes's equation: Flow over a plate, Flow in inlet of circular tubes, Creeping flow around a solid sphere.

Unit II: **[8 hrs]**
Turbulent and complex flows, Friction factors for flow in tubes, Dimensional analysis for friction factor, Experimental results for friction factor, Flow past submerged bodies, Flow through porous media, Fluidized beds, Energy balance applications in fluid flow, Bernoulli's theorem, Applications of Bernoulli's theorem: Flow from ladles, Flow measurements, Flow through piping networks.

Unit III: **[8 hrs]**
Introduction to various modes of heat transfer. Steady state condition - Fourier's law, Thermal Conductivity, Effect of variables on thermal conductivity, Critical thickness of insulation, shape factor in conduction, steady state heat conduction with heat generation, Heat conduction equations. Unsteady State Heat Conduction: Classification, Unsteady heat conduction in solids with infinite thermal conductivity, Lumped heat capacity analysis, unsteady heat conduction in solid with finite conduction and convection resistance in infinite thick solids with periodic

variation and in solids with given temperature distribution, topic related to differential solution of problems.

Unit IV: [**8 hrs**]

Convection Heat Transfer: Linear & Turbulent Flow, Hydro-dynamic and Thermal boundary layer, Fluid flow through tubes, channels and other configuration pressure drop, natural convection, dimensionless number and Heat transfer, Dimensional analysis in convective heat transfer, Empirical correlation for natural and forced convection heat transfer for various configurations, liquid metal convection heat transfer.

Unit V: [**8 hrs**]

Radiation Heat Transfer: Principles of radiation heat transfer, Terms in radiation, laws of radiation, Emissivity, Radiation heat transfer between black bodies, non - black bodies, radiation shape factors, shape factor algebra, Interchange factor.

Unit VI: [**8 hrs**]

Basic kinetics laws, order and molecularity of reactions, rate constant, elementary & complex reactions, Rate limiting steps and Arrhenius equation, Theories of reaction rates – simple collision theory, activated complex theory, Concept of activation energy. Diffusion and diffusion coefficient, Unsteady state mass transfer, differential formulation of mass transfer, Convective mass transfer, mass transfer coefficient.

Text Books:

- T.L. Bergman, A.S. Lavine, F.P. Incropera, D.P. Dewitt, Fundamentals of Heat and Mass Transfer, 7th Edition, 2011, John Wiley and Sons.
- D.R. Poirier, G.H. Geiger, Transport Phenomena in Materials Processing, 1st Edition, 1994, The Minerals, Metals and Materials Society.
- A.K. Mohanty, Rate Processes in Metallurgy, 1st Edition, 2004, Prentice Hall of India.
- D.R. Gaskell, An introduction to Transport Phenomena in Materials Engineering, 2nd Edition, 2012, Momentum Press.

Reference Books:

- R.B. Bird, W.E. Stewart, E.N. Lightfoot, Transport Phenomena, 2nd Edition, John Wiley and Sons.
- J. Welty, C.E. Wicks, R.E. Wilson, G.L. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 5th Edition, 2007, John Wiley and Sons.
- O. Levenspeil, Engineering Flow and Heat Exchanges, 3rd Edition, 2014, Springer.
- J.P. Holman, Heat Transfer, 10th Edition, 2010, McGraw Hill Higher Education.
- S. Kou, Transport Phenomena and Materials Processing, 1st Edition, 1996, John Wiley and Sons.

- J. Szekely, N.J. Themelis, Rate Phenomena in Process Metallurgy, 1st Edition, 1971, Wiley Interscience.

Environmental Studies

Teaching Scheme:
Lectures : 1 Hrs/week

Examination Scheme:
T1 and T2: 25 Marks each
End-Sem Exam: 50 Marks

Course Outcomes:
At the end of course

1. Students will understand the concept of environment and its importance for the mankind.
2. Students will also become aware of the current issues and environmental problems at local, national and global level
3. Students will be sensitized towards the protection, conservation and sustainable development
4. Students will think seriously about the impact human actions on environment and measures to minimize and mitigate them as an engineer
5. Students will learn about their role as professionals in protecting the environment from degradation

Unit I:	**The Global environmental issues** Human population and environment : Population growth, Environment and human health, Women and child welfare Social issues and environment : People and environment, Social consequences of development and Environmental changes	**[2 hrs]**
Unit II:	**Natural resources** Concept, spheres, Direct & Indirect utilization of natural resources, Types - Renewable and non-renewable, Overexploitation & pollution, Conservation - 3R principle	**[2 hrs]**
Unit III:	**Ecosystem** Concept, Types – Terrestrial & aquatic with subtypes, Function, Food chain & web, Energy pyramid, Niche, Ecotone	**[4 hrs]**
Unit IV:	**Biodiversity** Introduction, levels, Types, Distribution & Magnitude, Threats, Conservation	**[4 hrs]**
Unit V:	**Pollution** Concept, Types & Sources, Direct & indirect Impacts, Prevention, control and mitigation measures, Disaster management	**[4 hrs]**
Unit VI:	**Environmental rules and regulations** Concepts, Local, national and Global level framework, tools like Environmental Impact Assessment, Environmental Management System, Certifications, Role of an engineer in environmental management	**[4 hrs]**

Text books:

- Bharucha, E. (2013) Textbook of Environmental Studies for Undergraduate Courses.
- Rajgopalan, R (2011) Environmental Studies: From Crisis to Cure. Oxford University Press
- Wright, RT (2007) Environmental Science. Pearson Education (Low Prise 9th Edition) 712 p.

Reference books:

- Carson, Rachel (1962) The Silent Spring
- Leelakrishnan, P. (2006) Environmental Law Case Book (IInd Edition) LexisNexis Butterworths (Student Serise) 466 p.
- McKibben, Bill (1989) The end of Nature
- Meadows, Donella, Meadows Dennis & Randers Jorgen (1996) Beyond the limits
- Odum, EP (1971) Fundamentals of Ecology, W.B. Saunders (Publi.). 574 p.
- United Nations Environment Program (2005) Atlas of Our Changing Environment
- Weisman, Alan (2007) The World without us

Important web resources:

- Official websites of UNEP, UNESCO, MoEFCC, various NGO's

English Language Proficiency-I

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
T1 and T2: 25 Marks each
End-Sem Exam: 50 Marks

Course Outcomes:

At the end of course

1. Students will be able to communicate well using meaningful sentences for conversations or speeches.
2. They will be able to reproduce their understanding of concepts of communicating using English language
3. Students will be able to read and comprehend communication well and write effectively and enhance formal communication
4. Students will be able to better Presentation skills and participate in healthy discussions both formal and informal among peers.
5. They will be more confident facing interviews, acquiring professional skills and will be industry ready

Unit 1:	Communication as a skill Review of the basic understanding of communication as a skill and its need for effective business communication for Engineers	**[3 hrs]**
Unit 2:	Conversational Skill Development Formal and informal expressions, general discussions, Vocabulary Building	**[4 hrs]**
Unit 3:	Business Communication Letter Writing, Note making, Minutes, Summarizing,	**[4 hrs]**
Unit 4:	Business Etiquette Basic Mannerisms and Grooming required for professionals	**[3 hrs]**

Text books:

- Communication Skills for Technical Students by T.M. Farhathullah (Orient Longman)
- Communication for Business: A Practical Approach by Shirley Tailor (Longman)

Reference Books:

- Communication Skills for Engineers by S. Mishra & C. Muralikrishna (Pearson)
- Written Communication in English by Saran Freeman (Orient Longman)
- Essential English Grammar (Elementary & Intermediate) Raymond Murphy (CUP)
- Enhancing Employability at Soft Skills by Shalini Varma (Pearson)

Engineering Economics-I

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
Field Work/Assignments: 40 Marks
End-Sem Exam: 60 Marks

Course Outcomes (CO)

At the end of course

1. Students would understand the nature of markets and competition
2. Students would learn about Basic Concepts of Economics, Micro and Macro
3. Students would understand the importance of how industries behave
4. Students would understand the basis in our day to day life to gain personal financial control
5. Students would learn about start-up culture and economics
6. Students would get to know finance generation and funding rounds

Unit I: Basic Concepts of Economics **[6 hrs]**

Definitions, Overview of Micro and Macro Economics, Explanation of theories of demand, supply and market equilibrium and Economics Basics – Cost, efficiency and scarcity**,** Opportunity Cost

Unit II: Micro Economics **[8 hrs]**

Differences and Comparison, Theories of Utility and Consumers Choice, Competition and Market Structures, Markets and Prices, Market Failures, Income Distribution and Role of Government

Unit III: Macro Economics **[6 hrs]**

Aggregate Demand and Supply, Economic Growth and Business Cycles, The role of the Nation in economic activity, New Economic Policy in India, Fiscal Policy, GDP and Inflation, Consumption, savings and investments, Commercial and Central banking

Unit IV: **Industrial Economics** **[8 hrs]**

Behaviour of firms: Strategies with regard to entry, pricing, advertising, and R & D and innovation. The development of Firms and Market and Industrial Structure: Stochastic models of firm growth, and market structure, inter-industry differences in growth rate variance, economies of scale, technical change, mergers and market concentration. Development of Competitive capabilities: Role of Technology and Skills, FDI and Technology Transfer, Technological Spillovers, Globalization and Technology Intermediation.

Text Books:

- Baumol, William J., Economic Theory and Operations Analysis, [Prentice Hall India Ltd.] Fourth Edition, 1985.
- Sloman, John H., Economics [Prentice Hall India Ltd.] Second Edition, 1994.
- Varian, Hal, ` Intermediate Microeconomics: A Modern Approach, Fifth Edition [Norton, 1999].
- P.A. Samuelson & W.D. Nordhaus, Economics, McGraw Hill, New York, 1995.
- Koutsoyiannis, Modern Microeconomics, Macmillan, 1975.
- R. Pindyck and D.L. Rubinfeld, Microeconomics, Macmillan Publishing Company, New York, 1989.

Reference:

- R.J. Gordon, Macroeconomics 4th Edition, Little Brown & Co., Boston, 1987.
- William F. Shughart II, The Organization of Industry, Richard D. Irwin, Illinois, 1990. (Chapter 3).

Industrial Psychology-I

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
Field Work/Assignments: 40 Marks
End-Sem Exam: 60 Marks

Course Outcomes (CO)

At the end of course

1. Students would understand the nature, scope, challenges and role of technology in Industrial Psychology
2. Students would learn about major psychological factors that influence individual differences in behaviour at work
3. Students would understand the importance of motivation and involvement in determining satisfaction at work
4. Students would understand the elements of psychometric testing and develop skills to face the same in future
5. Students would learn about physical and psychological aspects related to workplace in terms of environmental conditions, safety and health
6. Students would get to know the stressors of work and learn coping strategies to strike work-life balance
7. Students would understand the role of human factors, especially sensory systems and cognitive abilities, in designs that promote man-machine harmony
8. Students would demonstrate the knowledge gained through practical implementation

Unit I: **[6 hrs]**

Introduction to Industrial Psychology

Nature and Development of Industrial/Work Psychology, Historical background- Time and Motion Study, Hawthorne Studies, World War I & II, Scope & Challenges: Current status Role of Technology

Unit II: **[8 hrs]**

People at Work

Individual Differences: Personality, Intelligence, Emotional Intelligence, Creativity & Innovation, Perception & Attitudes Motivation- N-Ach, Expectancy Theory & Equity Theory, Modern Approach to Motivation; Job Satisfaction- Job Diagnostic Model, Measuring Job Satisfaction, Psychometric Testing at Work- Cognitive Abilities, Personality, Emotional Intelligence

Unit III: **[6 hrs]**

Characteristics of Workplace

Working Conditions- Physical (e.g. Work Schedule, etc.) & Psychological (e.g. Fatigue, Boredom, etc.), Safety & Health Practices at Workplace- Accidents, Violence, Harassment, Alcoholism & Drug, Stress at Workplace- Individual Responses to Stress; 3 Cs of Stress- Causes, Consequences & Coping with Work Stress

Unit IV: **[8 hrs]**

Engineering Psychology-I

Brief History and Scope, Person-Machine Systems- Basic Human Factors: Sensory systems- Visual (light, colour, night vision, depth perception), Auditory (sound, alarms, noise), Tactile & Vestibular senses; Cognition & Decision Making, Displays: Visual & Auditory Control

Text Books:

- Schultz, D. & Schultz, S. E. (2013). Psychology and Work Today: An Introduction to Industrial and Organizational Psychology. 7th Edition. Pearson Education: New Delhi.
- Matthewman, L., Rose, A. & Hetherington, A. (2009). Work Psychology. Oxford University Press: India.
- Wickens, C. D.; Lee, J. D., Liu, Y. & Gordon Becker, S. E. (2015). An Introduction to Human Factors Engineering. 2nd Edition. Pearson Education: New Delhi.

References:

- Landy, F. J. & Conte, J. M. (2010). Work in the 21st Century: An Introduction to Industrial and Organizational Psychology. 2nd Edition. Wiley India: New Delhi.
- Schultz, D. & Schultz, S. E. (2002). Psychology and Work Today. Pearson Education: New Delhi.

Personnel Psychology-I

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
Assignments: 60 Marks
End-Sem Exam: 40 Marks

Course Outcomes

At the end of the course

1. Students will have understanding of organizational concepts and behavior.
2. Students will have understanding about their own personality for corporate world.
3. Students will understand importance of groups and its dynamics.
4. Students will understand the importance of self management and development.

Unit I: **[2 hrs]**

Introduction Basic concepts in Organizational set up and its importance

Unit II: **[8 hrs]**

Personality and corporate world Know and accept yourself. Preparing for corporate world, approaches towards work

Unit III: **[8 hrs]**

Group behavior and leadership Group behavior and effectiveness, effective leadership and management principles

Unit IV: **[4 hrs]**

Self management & development Efficient working habits, self training and self development

Text Books:

- Khana S.S. (2016) Organizational Behaviour(Text and Cases) Chand and company Pvt. Ltd. Delhi.
- Rae Andr'e (2008) organizational behavior. Dorling Kindersley (India) Pvt. Ltd.
- Wallace Hand Masters L.- (2008) Personality development..Cengage Learning India Pvt. Ltd.

Referece books:

- Robbins S, JudgeA, Vohra N (2013) Organizational behavior.(15th ed) Pearson Education,Inc.
- Singh Kavita (2010) Organizational behavior-Text and cases. Dorling Kindersley (India) Pvt. Ltd.

Japanese Language–I

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
Oral: 20 Marks
End-Sem Exam: 80 Marks

Course Outcomes (CO)

At the end of course

1. Students would know the basic information of Japan
2. Students would be familiar with the pronunciation, Accent, Intonation and Japanese writing System Hiragana, Katakana and Kanji
3. Students would be able to speak daily greetings
4. Students would be able to count the numerals
5. Students would be able to introduce themselves, Family members
6. Students would be able to form basic questions
7. Students would be able to understand Colors, Years ,Months and Days, Time expressions, Directions to read the city map

Unit I: **[06 hrs]**

Introduction to Japanese Syllables (phonetic alphabet), greetings & Self introduction, Identifying things, point objects and listen to their names, Listen to things and places etc. Creating shopping lists.

Unit II: **[06 hrs]**

Introduction to Time, day of the week, simple inquiries on telephone, Means of transport, Basic conversations of everyday life.

Unit III: **[06 hrs]**

Frame questions in Japanese. Vocabulary of giving and receiving objects, Stating impressions/things surrounding us, Expressing likes and dislikes, good/bad, possessions, Talking about the country, town and the environment.

Unit IV: **[06 hrs]**

Quantity, number of people, time, period etc., Stating thoughts and impressions, Conveying movement (e.g. go / come).

Text book:

1. Minnano no Nihongo 1-1.Goyal Publishers& Distributors Pvt. Ltd. Delhi, India

German Language -I

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
Oral: 20 Marks
End-Sem Exam: 80 Marks

Course Outcomes:

At the end of the course

1. Students would know the basic information of Germany
2. Students would be familiar with the pronunciation of German letters and greetings
3. Students would be able to count till 100
4. Students would be able to introduce themselves
5. Students would be able to form basic questions
6. Students would be able to read the city map

Unit I : **[08 hrs]**

Start auf Deutsch: (Begin in German)

Deutschland, Deutsch sehen und hören, erste Kontakte, Texte: Lied, Postkarte, Wortfelder: internationale Wörter, deutsche Namen

Unit II : **[06 hrs]**

Café: (Café)

Gespräche im Café, Texte: Getränkekarte, Telefonbuch, Rechnungen, Wortfelder: Gespräche im Café, Zahlen bis 100, Strukturwörter

Unit III: **[05 hrs]**

Städte, Länder, Sprachen: (Cities, Countries, Languages)

Sehenswürdigkeiten in Europa, Sprachen in Europa, Nachbarsprachen, Texte: Landkarten, ein Statistik, Wortfelder: Himmelsrichtungen, Sprachen

Unit IV: **[05 hrs]**

Menschen und Haüser: (People and Houses)

Wohnwelten, Texte: Möbelkatalog, E-Mail, Wohnungsgrundriss, Wortfelder: Räume und Möbel, Wohnformen

Reference:

- Funk, Kuhn, & Demme. Studio d A1. Deutsch als Fremdsprache. 2011. Goyal Publishers & Distributors Pvt. Ltd. Delhi, India.

Heat Treatment Technology Laboratory

Teaching Scheme:
Laboratory: 2 hrs/week

Examination Scheme:
Continuous evaluation - 50 Marks
End Sem exam - 50 Marks

Course Outcomes:
At the end of course students will be able to

1. Perform the annealing, normalizing, hardening, carburizing, nitriding etc. heat treatment of steels.
2. Determine the hardenability of steel using ASTM standard test
3. Design of isothermal heat treatment cycle using TTT/CCT diagram
4. Perform hardening and tempering on high strength steel
5. Optimize the time and temperature of age hardening treatment for age hardenable Al alloys

List of Experiments: (Any 08 from the given below)

1. Performing annealing, normalizing and hardening heat treatment of steel samples; observation of microstructures and hardness.
2. Designing of Spheroidizing annealing cycle for eutectoid steel.
3. Design of isothermal heat treatment cycle using TTT/CCT diagram using fluidized bed and salt bath furnace.
4. Hardenability determination by Jominy End Quench test as per ASTM standard; estimation of hardenability using composition of steel.
5. Performing hardening and tempering on high strength steel
6. Performing Hardening and multiple tempering of High Speed Steel.
7. Performing surface heat treatments like carburizing, nitriding on steels; estimating resultant case depth.
8. Observation and description of microstructure of typical alloy steels such as micro-alloyed steel, dual phase steel, free cutting steel, bearing steel and maraging steel.
9. Performing maraging heat treatment on maraging grade steels
10. Observation and description of microstructure of various stainless steels.
11. Design of precipitation hardening treatment of age hardenable aluminium alloys.
12. Case Study of defects due to heat treatment and remedial design changes

Heat Treatment Technology

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:
At the end of course students will be able to

1. Understand the basic principles of various heat treatments.
2. Analyse the effect of heat treatment processes on the structure and properties of materials
3. Understand the basics of heat treatments given to micro-lloy steel, dual phase steel, tool steel maraging steel and stainless steel
4. Understand the fundamentas of surfce heat treatments given to steels
5. Analyse effect of furnace atmospheres on heat treatment processes and reasons behind defects after heat treatments

Unit I: **[6 hrs]**

Heat treatment of plain carbon steels: Annealing, Isothermal and subcritical Annealing types, Normalizing, Hardening Heat Treatment: Quenching process, characteristics and kinetics of martensitic transformation, Bain model, Retained austenite and its effect, Tempering and subzero treatment. Hardenability: Mass effect, Grossman method, Critical and ideal critical diameter, Jominy End Quench method, Use and Significance of Hardenability data, Effect of grain size and composition, Residual stresses, Quench cracking, Case studies of design changes for hardening.

Unit II: **[6 hrs]**

Classification of alloying elements and their effects on Iron–Iron carbide phase diagram, TTT Diagram and CCT Diagram, General Heat treatments such as Annealing, Normalizing, Hardening, Tempering, Austempering, Martempering, Hardenability concept, Stages of Quenching and their effects, Types of quenching media such as oils, polymers; Cooling characteristics of quenching media, Control of quenching parameters, quenching fixtures, Dimensional changes during hardening and tempering

Unit III: **[6 hrs]**

Introduction to classification and Heat treatment of Low alloy steels: Micro- alloyed (HSLA), Dual phase steels, Free cutting steels, Spring steels; bearing steel, Tool Steel: Selection criteria

and properties of Tool steels, Classification of Tool Steels: Cold work, Hot Work Tool Steels, High Speed Steels and Stellites; Heat treatments of Die and Tool steels, Secondary hardness and Red Hardness, Subzero treatment, Super High Speed Steels, TRIP Steels.

Unit IV: **[7 hrs]**

Stainless Steels: Fe-Cr, Fe-Ni Phase Diagram, Schaeffler Diagram and its modifications, Classification of Stainless Steels, sensitization, Heat treatment of stainless steels, Precipitation Hardening Stainless Steels, Marageing Steels, Superalloys and their heat treatment.

Unit V: **[6 hrs]**

Surface hardening: Carburizing, Carburizing atmosphere and Heat treatment after Case Hardening, Bainite control in case, Case depth measurement, ASTM E1077-01 Depth of carburization, Drip Feed Carburizing, dimensional changes during case hardening; Nitriding, Carbonitriding, Tufftriding, Nitrocarburising, Plasma Nitriding; Induction Hardening, Flame Hardening, Laser Hardening, Selection of steels for these treatments and their applications.

Unit VI: **[6 hrs]**

Classification of atmospheres for heat treatments, Generation of atmospheres and their applications. In situ atmosphere generation, Thermodynamics and Kinetics of atmospheres, Control and monitoring of Furnace Atmospheres: Infrared controller, Gas chromatography, Dew point analyzer and Oxygen probe analyzer Heat treating furnaces: Salt bath furnace, Fluidized bed furnace, Sealed Quench furnace, Vacuum furnace, Heat Treatment Defects such as Distortion, Residual stresses, quench cracks and Design for Heat treatment

Text Books:

- Heat Treatment of Metals, Vijendra Singh, 2007, Standard Publishers and Distributors, New Delhi
- R.A. Higgins, Engineering Metallurgy, Part I, App. Physical Met, ELBS, 5th ed., 1983

Reference Books:

- Steel and its Heat Treatment -K.E Thelning, Butterworth, London
- Handbook of Heat Treatment of Steels – Prabhudev-Tata McGraw Hill. New Delhi, 1988
- Heat Treatment of Ferrous Alloys, Brooks, Washington: Hemisphere Pub., 1979
- ASM Metals Handbook – Heat treatment, Metals Park Ohio Pub.
- ASM Metals Handbook – Steels, Metals Park Ohio Pub.

Iron Making

Teaching Scheme:
Lectures : 3 Hrs/week

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

Course Outcomes:

At the end of course students will be able to

1. Develop an ability to apply the knowledge of science (e.g. thermodynamics) for the extraction of iron from ore and therefore, this course makes the student technically sound in the area of iron production from iron ore.
2. Understand necessity for developing alternate routes for iron-making because the blast furnace route demands resources like, coke, which is depleting rapidly across the world.
3. Understand the need for life-long learning so that the metallurgists will be familiar with the latest advances in the iron-making technology.

Unit I: **[6 hrs]**
Iron making: Historical, blast furnace process, Raw materials- iron ore, coke, fluxes, burden preparation.

Unit II: **[6 hrs]**
Treatment of iron ores: Agglomeration, sintering and pelletization, Coke making, coke oven gas & BF flue Gas, Chemical by-products, gas cleaning system.

Unit III: **[6 hrs]**
Physical chemistry of blast furnace reactions, thermodynamic equilibria, chemical and thermal reaction zones, Reactions in stack, bosh and hearth, thermal efficiency, mass and enthalpy balances, gas flow, burden distribution and cohesive zone formation in BF.

Unit IV: **[6 hrs]**
Construction of Blast furnace and accessories, B.F. operation, performance, gas utilization, Irregularities in B.F. operation, products: metal and slag, Mini-blast furnace, COREX process-principles of operation, techno-economical considerations.

Unit V: **[6 hrs]**
Alternatives routes of iron production, low shaft furnace, electro thermal processes, Directly reduced iron (DRI) productions: Principles of operations, Physical chemistry of DRI processes, mechanism of sponge iron production, advantages and disadvantages, Processes such as – Rotary Kiln, MIDREX.

Unit VI: **[6 hrs]**
Ferro-alloys production: Methods of production, Electric submerged arc furnace, metallothermic processes, Ferrochrome, Ferrosilicon, Ferromanganese, Ca-Si, Si-Mn.

Text Books:

- R.H. Tupkary, V.R.Tupkary, An Introduction to modern Iron making, 3rd Edition, Khanna Publications, New Delhi, 2005.
- AhindraGhosh, AmitChatterjee Iron and Steel making: Theory and practice, 2nd Edition, PHI learning Pvt. Ltd, New Delhi, 2011.
- A.K. Biswas: Principles of Blast Furnace Iron making, 1st Edition, SBA publications, Calcutta, 1984.
- F.P. Edneral, Electrometallurgy of Steel and Ferroalloys, Volume I and II, 4th Edition, Russia, 1979.

Reference Books:

- J.G. Peacey, W.G. Davenport, Daven Port, The iron Blast furnace: Theory and practice, Pregamon press, New York, 1979.
- AmitChatterjee, Beyond the Blast furnace, CRC Press; 1st Edition, Boca Raton, 1993.
- National Steel Policy (NSP), Ministry of Steel, Government of India, 2012.

Mineral Processing and Extractive Metallurgy

Teaching Scheme:
Lectures : 4 Hrs/week

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

Course Outcomes:

At the end of course students will be able to

1. Understand preparation of ore concentrates and extraction of the non ferrous metals such as Cu, Zn etc, by pyrometallurgical technique with high yield
2. Understand extraction of Aluminium with high yield using electrolysis technique
3. Theoretically apply the hydrometallurgy technology to extract the non ferrous metals
4. Analyse the efficiency of extraction process considering thermodynamic aspects.
5. Understand refinement of metals to reduce the impurities and oxygen content

Unit I: **[6 hrs]**

Introduction to ore dressing, grinding and its types, Grinding mills, Comminution laws, Sizing: Industrial sizing units: Types of screen surfaces. Grizzlies, trammels, vibrating and shaking screens, Movement of solids in fluids: stokes and Newton's law, Terminal velocity and its relation with size, Classification of classifiers, Heavy media separation: Principles, flow chart, different media used. Theory of jigging and jigging machines, Floatation: Principles of floatation, Factors affecting floatation, Classification of collectors and frothers, Magnetic separation processes and electrostatic separation process.

Unit II: **[6 hrs]**

Locations of ore deposits of nonferrous metals and their production in India and abroad, Main approaches in extractive metallurgy: Pyrometallurgy, Hydrometallurgy and Electrometallurgy. Thermodynamic considerations and process selection in extraction of metals, Study of free energy diagram, Leaching, bioleaching, precipitation of metals, reduction by gases**.**

Unit III: **[6 hrs]**

Copper ores, Locations of their deposits in India and abroad, Pyrometallurgical extraction ofCopper thermal treatment, sulphation of oxides, oxidation of sulphides, matte formation,chlorination, fluorination, Copper loss in slag, Hydrometallurgical extraction of Copper, Newerroutes**.**

Unit IV: **[6 hrs]**

Aluminium ores, Locations of ores deposits in India and abroad, principle of electrolysis in winning, fused salt electrolysis, Bayer’s process for production of alumina, Hall-Heroult process, Refining of Aluminium, Newer routes

Unit V: **[6 hrs]**

Lead and Zinc ores, Locations of ores deposits in India and abroad, Lead smelting, Pyrometallurgical extraction of Zinc, Hydrometallurgical extraction of Zinc, Imperial smelting

process, Extraction processes of Nickel.**]**

Unit VI: **[6 hrs]**

Ore deposits of tin, magnesium, gold, zirconium, titanium, in India and abroad, Extraction of tin, magnesium, gold, zirconium, titanium,. Ion exchange and solvent extraction processes. Present scenario of production of above mentioned metals, Secondary metals, Recovery of metals from scrap and other secondary sources by pyro-, hydro- and electrometallurgy.

Text Books:

- H. S. Ray, R. Shreedhar and K.P. Abraham, Extraction of Non-Ferrous Metals, Affiliated East West press pvt. Ltd, Oscar Publications, New Delhi, 2011.
- R. D. Pehlke, Unit Processes in Extractive Metallurgy, American Elsevier pub. Co., Michigan, 1973.
- J. J. Moore, Chemical metallurgy, Butterworth-Heineman, 1981.
- J. D. Gilchrist, Extractive metallurgy, Pergamon Press, 1989.

Reference Books:

- W. G. Davenport, M. King, M. Schlesinger , and A. K. Bishwas, Extractive metallurgy of Copper, 4^{th} edition, Pergamon Press, 2002.
- H. S. Ray, A. Ghosh, Processes in Extractive Metallurgy, New age international pvt.ltd, New Delhi, 2001.

Mineral Processing and Extractive Metallurgy Laboratory

Teaching Scheme:
Laboratory : 2 Hrs/week

Examination Scheme:
Continuous Evaluation – 50 marks
End Sem Exam – 50 marks

Course Outcomes:

At the end of course students will be able to

1. Prepare the ore concentrates
2. Manufacture the metal by reduction of ore using pyrometallurgy and hydrometallurgy technique
3. Calculate the temperature, energy required and yield of metal produced.

List of Experiments:

1. Crushing of ores by Roll crusher and Jaw crusher.
2. Study of grinding process
3. Palletizing of Iron Ores
4. Study of Calcination of calcium carbonate .
5. Kinetics study of Cementation of Copper.
6. Aluminothermy reduction of iron ore
7. Hydrometallurgy of copper and Zinc
8. Numericals on nonferrous extraction.
9. Assignments based on present scenario of non ferrous metals in India and Abroad.

Department Elective:

Wire Drawing & Sheet Metal Forming

Teaching Scheme:
Lectures : 3 Hr/week

Examination Scheme:
T1 and T2: 20 Marks each
End Sem exam : 60 marks

Course Outcomes (CO):
At the end of course students will be able to

1. Know the usefulness of various mechanical working processes and the mechanical metallurgy behind it.
2. Know process mechanics and characteristics of wire drawing and to design the process depending on the wire geometry and material.
3. Know of manufacturing, microstructure, properties and applications of Sheet Metal.
4. Select the inspection techniques based on application, fabrication and service conditions.

Unit I: **[6 hrs]**

Introduction to Mechanical working

Basics of metal forming, hot, cold and warm working of metals, strain rates in metal forming, an overview of elementary stress analysis and yield criteria, description and analysis of various bulk forming processes(forging, extrusion, wire drawing and rolling), concept of Workability. Understanding the influence of alloying elements, temperature and cooling rates post deformation processing (recovery, recrystallization and grain growth) on the evolution of microstructure and properties.

Unit II: **[6 hrs]**

Drawing of rods, wires and tubes:

Theory and practice of wire drawing, Wire drawing equipment, drawing die and die design, calculations of optimum die parameters, the Stelmor cooling process, Fundamentals of wire processing – acid pickling and descaling, coatings, lubricants, heat treatment on wire - annealing and tempering, patenting , drawing strains, strain rate.

Unit III: **[6 hrs]**

Testing and applications of wire

Mechanical testing–Hardness, tensile testing (yield strength, Ultimate Tensile Strength, ductility measurement - reduction of area), torsion, fatigue. NDT Techniques – Eddy Current Testing, Defects and failure analysis – inclusions, centerburst, crow feet, die chatter, galling, applications of wires and their basic principles.

Unit IV: **[6 hrs]**

Introduction to Sheet metal working

Introduction to sheet metal working, selection of forming equipments – dies and presses, shearing operation, clearance, angular clearance, blanking die design, drawing- blank size calculations, forming limit criteria, number of draws, drawing force, Bending- Bend allowance, bending force calculations, springback and springback compensation.

Unit V: **[6 hrs]**

Sheet Metal Forming Processes

Sheet hydroforming, Incremental sheet metal forming, Explosive forming, Superplastic Forming, Electrohydraulic and Magnetic-Pulse Forming, Peen-Forming, Forming Limit Diagram, Sheet Metal Cutting, Slotting, Perforating and Notching of Sheets,

Unit VI: **[6 hrs]**

Testing and applications of Sheet Metal

Formability Testing, Cupping test on sheet metal, defects in Sheet Metal Forming and their mitigation, applications of sheet metals , Economics of Sheet-Metal Forming, application of software in Sheet Metal Working.

Text Books:

- Steel Wire Handbook – Vol 1-4, edited by Allan B. Dove, The Wire Association
- Mechanical Metallurgy, 3rd Edition, George E Dieter, McGraw-Hill, London,1988.
- Serope Kalpakjian & Steven R. Schmid, "Manufacturing processes for engineering materials

Reference Books:

- International Branford, 1965,1968, 1969, 1972 Ferrous Wire – Volume 1 and 2, The Wire Association International
- Electrical Wire Handbook – Part 1 and 2, The Wire Association International• Physical Metallurgy Principles, Reed-Hill, 2nd ed, East West Press, New Delhi, 1973
- Heat Treatment, ASM Handbook, Vol.4, ASM International, Ohio, 1991
- Research Articles from Technical Publications and Conferences.

Department Elective:

Non Destructive Testing

Teaching Scheme:
Lectures : 3 Hr/week

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

Course outcomes:
At the end of course students will be able to

1. Understand basics principles behind all important NDTs
2. Select proper method of NDT for detection of given type of defect
3. Interpret results of ultrasonic testing and X-ray radiography
4. Interpret results of eddy current testing and Acoustic Emission Testing

Unit I: **[6 hrs]**

Introduction of NDTs: Non destructive testing and its comparison with destructive testing, role of NDT in quality control, visual optical methods, dye penetrant testing, basic principle, types and characteristics of dye, methods of application, developer, evaluation, advantages, limitations and applications of DPT

Unit II: **[6 hrs]**

Magnetic particle testing: Basic theory of magnetism, magnetization methods, magnetic particle testing equipment, testing procedures, method of demagnetization, magnetic particle medium- evaluations of indications, acceptance standards, advantages, limitations and applications.

Unit III: **[6 hrs]**

Eddy current testing: Basic principle, Faraday's law, Inductance, Lenz's law, self and mutual inductance, impedance plane, equipments, techniques used for ECT, advantages, limitations and applications.

Unit IV: **[6 hrs]**

Radiography: Basic principles, electromagnetic radiation sources, effect of radiation in film, radiographic imaging, image formation, image quality, digital radiography, image interpretation, radiation shielding, inspection equipments and techniques, precaution against radiation hazards, advantages, limitations and applications.

Unit V: **[6 hrs]**

Ultrasonic Testing: Principle of operation, basics of ultrasonic waves, pulse and beam shapes, ultrasonic transducers, equipments and testing procedures, type of display, method of evaluation of discontinuities, identification of defects, advantages, limitations and applications

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Unit VI: **[6 hrs]**

Acoustic Emission Testing (AET): Basic principles, sources of acoustic emission, source parameters, Kaiser-Felicity theory, technique, instrumentation and applications, miscellaneous tests.

Text Books:

- Baldev Raj, T. Jayakumar, M. Thavasimuthu, Practical Non-Destructive Testing, 3rd Ed., Narosa.
- J. Prasad , C.G.K. Nair, Non Destructive Testing and Evaluation of Materials, Tata MacGraw Hill

Reference Books:

- Baldev Raj, T. Jayakumar, M. Thavasimuthu, Practical Non-Destructive Testing, 3rd Ed., Narosa.
- J. Prasad , C.G.K. Nair, Non Destructive Testing and Evaluation of Materials, Tata MacGraw Hill
- B. Hull, Non Destructive Testing, Springer.
- ASM Metals Handbook, Non Destructive Evaluation and Quality Control, Vol. 17, 9th Ed.
- Louis Cartz, Nondestructive Testing, ASM International

Department Elective:

Tribology of Materials

Teaching Scheme: **Examination Scheme:**

Lectures : 3 Hrs/week

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

Course outcomes:
At the end of course students will be able to

1. Suggest solutions based on improved materials selection, use of tribological coatings, improved design or improved lubrication.
2. Explain the different wear processes in contacts between metallic, ceramic and polymeric surfaces
3. Select a suitable material combination for tribological contacts
4. Explain the different wear processes in contacts between metallic, ceramic and polymeric surfaces
5. Design a wear and friction test and interpret the results

Unit I: **[6 hrs]**

Introduction to Tribology

Introduction to tribology, history of tribology, definitions and development of wear studies, , factors influencing tribological phenomena, properties of materials relevant to friction and wear, scope and challenges

Unit II: **[6 hrs]**

Surfaces, Friction and Wear

Contact of engineering surfaces: Hertzian and non-hertzian contact, contact pressure and deformation in non-conformal contacts, causes of friction, stick-slip friction behaviour and friction instability, sliding and rolling friction, frictional heating and temperature rise, wear and wear types, mechanisms of wear

Unit III: **[6 hrs]**

Lubrication

Lubricants and their physical properties, types of additives, extreme pressure lubricants, recycling of used oils and oil conservation, oil emulsion, selection of lubricants, hydrodynamic lubrication: Reynolds equation, infinite bearing, short bearing, elastohydrodynamic lubrication: principle and application, pressure - viscosity term in Reynolds equation, Hertz theory, Ertel-Grubin equation, Gas lubrication: Introduction, merits, demerits and applications, Lubrication in metal working: rolling, forging, drawing and extrusion.

Unit IV: **[6 hrs]**

Surface Engineering for wear and corrosion resistance

Diffusion, coating, electro and electro-less plating, hot deep coating, metal spraying, cladded coating, crystallizing coating, selection of coating for wear and corrosion resistance, potential properties and parameters of coating.

Unit V: **[6 hrs]**

Wear monitoring, diagnosis and characterization techniques

Surface examination, vibration analysis, lubricant analysis, wear and friction measurement techniques, characterization of roughness and wear scar dimensions, microscopy techniques, micromechanical properties techniques, thermal, chemical and x-ray methods

Unit VI: **[6 hrs]**

Tribology of Engineering materials

Tribology of brass, cast iron and aluminium-silicon alloys, tribology of metal matrix composites, tribology of ceramic matrix composites, tribology of polymeric solids and their composites, tribology of diamond and diamond-like carbon films

Text Books:

- Wear of Metals, A.D. Sarkar, Pergamon Press, Oxford
- Tribology, Friction and Wear of Engineering Material, I. M.Hutchings, Edward Arnold, London.
- Principles and Application of Tribology, B. Bhushan, Wiley.

Reference Books:

- Basic Lubrication Theory, A. Cameron, Ellis Hardwoods Ltd., UK.
- Fundamentals of Tribology, S. K. Basu, S. N.Sengupatha and D. B.Ahuja, PHI.
- Engineering Tribology, J. A. Williams, Oxford Univ. Press.
- Introduction to Tribology in bearings, B. C. Majumdar, Wheeler Publishing.
- Tribology, Friction and Wear of Engineering Material, I. M.Hutchings, Edward Arnold, London.
- Engineering Tribology, G. W. Stachowiak and A. W. Batchelor, Butterworth-Heinemann.
- Engineering Tribology, P. Sahoo, PHI, New Delhi.
- Applied Tribology: Bearing Design and Lubrication, M. M. Khonsari, E. R. Booser, Wiley.

Entrepreneurship Development

Teaching Scheme:
Lectures : 1 Hrs/week

Examination Scheme:
Field Work/ Assignments: 40 Marks
End-Sem Exam: 60 Marks

Course Outcomes (CO)

1. Students would understand different types of Entrepreneurial ventures and would be able to discover, develop, and assess opportunities
2. Students would learn about opportunity and risk analysis
3. Students would understand the strategies for valuing your own company, and how venture capitalist and angel investors use valuations in negotiating milestones, influence and control
4. Students would understand to pick correct marketing mix and how to position the company in the market by using analytical tools
5. Students would learn how to sale themselves and the product/service and to handle objections
6. Students would get to know how organizations operates and their process matrices
7. Students will learn how start new ventures
8. Students will learn how to write winning business plans

Unit I: Market Research **[2 hrs]**

Introduction to Entrepreneurship, Profile of the Entrepreneur, Market Gap / Opportunity Analysis, Market Research Methods, Defining the Focal Market: Market Segmentation, Industry analyzing – Research / Competitive Analysis

Unit II: Types of Companies and Organizations **[1 hr]**

Company/ Organization Types, Legal Aspects, Taxation, Government Liaison, Building the Team, Mergers and Acquisitions

Unit III: Business Finance **[2 hrs]**

Shares and Stakes, Valuation, Finance Creation (Investors / Financers), Revenue Plans and Projections, Financial Ratios, Business Lifecycle, Break Even

Unit IV: Marketing **[2 hrs]**

Marketing Basics, Marketing Strategy and Brand Positioning, Plans and Execution Techniques, Marketing Analytics, Online Marketing

Unit V: Sales **[2 hrs]**

Understanding Sales, Pitching Techniques, Sales strategies, Inside Sales v/s Outside Sales, RFP

Unit VI: Operations Management **[1 hr]**

Operational Basics, Process Analysis, Productivity, Quality

Unit VII: Start-ups **[2 hrs]**

Start-up Basics, Terms, Start-up Financing, Start-up Incubation, Start-up Incubation, Getting Listed

Text Books:

- The Startup Playbook: Secrets of the Fastest-Growing Startups From Their Founding Entrepreneurs by David Kidder
- Creativity, Inc.: Overcoming the Unseen Forces That Stand in the Way of True Inspiration by Ed Catmull
- True North by Bill George and Peter Sims
- Bhargava, S. (2003). Transformational leadership: Value based management for Indian Organizations (Ed.). New Delhi: Response-Sage.
- Cardullo, M. W. P. E. (1999). Technological entrepreneurism: Enterprise formation, financing, and growyh. England: Research Studies press Ltd.
- Hisrich, R. D. & Peters, M. P. (2001). Entrepreneurship: Starting, developing, and managing a new enterprise (5th Ed.). New York: McGraw-Hill.

References:

- Kanungo, R. N. (1998). Entrepreneurship and innovation: Models for development (Ed., Vol.2). New Delhi: Sage.
- McClelland, D. C. (1961). Achieving society. Princeton
- Van Nostrand. Verma, J. C., & Singh, G. (2002). Small business and industry: A handbook for entrepreneurs. New Delhi: Response-Sage.
- Richard A Brealy & Steward C Myres. Principles of Corporate Finance, McGraw Hills, 7th Edn,2004

- Prasanna Chandra, Financial Management: Theory and Practice, Tata McGraw Hills, 6th Edn, 2004
- I M Pandey, Financial Management, Vikas Publishing, 9th Edn, 2004
- Aswath Damodaran, Corporate Finance-Theory and Practice , John Wiley & Sons, 1997

- I.M. Pandey & Ramesh Bhat, "Cases in Financial Management", Tata McGraw-Hill, New Delhi.
- Horowitch (ED), Technology in the modern Corporation: A Strategic perspective, Pergamon Press, 1986.
- *M. Dodgson (ED), Technology and the firm: Strategies, management 7 Public Policy, Longman, Harlow, 1989.*

Semester-VI

Constitution of India

Teaching Scheme:
Lectures: 1 hrs/week

Examination Scheme:
Continuous evaluation- 40 marks
End-Sem exam - 60 Marks

Course Outcomes
At the end of course

1. Student will be able to understand how India has come up with a Constitution which is the combination of the positive aspects of other Constitutions.
2. Student will be able to understand the interpretation of the Preamble.
3. Student will be able to understand the basics of governance of our nation.
4. It helps in understanding the different aspects covered under the different important Articles.
5. Student will be able to understand the basic law and its interpretation. Understand the important amendments which took place and their effects.
6. Student will be able to understand our Union and State Executive better.
7. Student will be able to understand the basic that along with enjoying the rights one needs to fulfill one's duties.
8. Student will be able to understand and Gain confidence on our Constitution by knowing it better.

Unit I: **[3 hrs]**
Meaning and history of Constitution.
Understanding the concept of Human Rights and Fundamental Rights.

Unit II: **[6 hrs]**
Introduction to The Constitution of India, understanding its objects. Preamble to the constitution of India.
Fundamental rights under Part – III, exercise of rights, limitations and important cases.
Prerogative Writs.

Unit III: **[4 hrs]**
Relevance of Directive principles of State Policy under Part – IV, Fundamental duties & their significance.

Unit IV: **[3 hrs]**
Union Executive – President, Prime Minister, Parliament & the Supreme Court of India.

Unit V: **[3 hrs]**
State executive – Governors, Chief Minister, State Legislature and High Courts

Unit VI: **[4 hrs]**

Constitutional Provisions for Scheduled Castes & Tribes, Women & Children & Backward classes.

Emergency Provisions.

Unit VII **[3 hrs]**

Electoral process.

Amendment procedure, 42^{nd} , 44^{th} , 73^{rd},74^{th} , 76^{th} , 86^{th} , 91^{st} , 98^{th} and latest amendment.

Constitutional amendments.

Text Books

- Introduction to the Constitution of India by Durga Das Basu (Students Edn.) Prentice – Hall EEE, 19th/20th Edn., 2001.
- Engineering Ethics by Charles E.Haries, Michael. S.Pritchard and Michael J.Robins Thompson Asia, 2003-08-05.

Reference Books

- An Introduction to Constitution of India by M.V. Pylee, Vikas Publishing.

English Language Proficiency-II

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
T1 and T2: 25 Marks each
End-Sem Exam: 50 Marks

Course Outcomes:
At the end of course

1. Students will be able to communicate well using meaningful sentences for conversations or speeches.
2. They will be able to reproduce their understanding of concepts of communicating using English language
3. Students will be able to read and comprehend communication well and write effectively and enhance formal communication
4. Students will be able to better Presentation skills and participate in healthy discussions both formal and informal among peers.
5. They will be more confident facing interviews, acquiring professional skills and will be industry ready

Unit 1: Linguistic Competence Building **[3 hrs]**
Enhancement of Word Power, Formal and Group Discussions

Unit 2: Presentation Skill Development **[3 hrs]**
Oral and Written Presentations

Unit 3: Business Writing **[4 hrs]**
Business Reports, CV, Resume, Statement of Purpose

Unit 4: Job Readiness **[4 hrs]**
Interview Skills and Mock Interviews

Text books:

- Communication Skills for Technical Students by T.M. Farhathullah (Orient Longman)
- Communication for Business: A Practical Approach by Shirley Tailor (Longman)

Reference Books:

- Corporate Communication by Jaishri Jethwaney (Oxford University Press)
- Written Communication in English by Saran Freeman (Orient Longman)

- Business Correspondence and Report Writing, R. C. Sharma & Krishna Mohan (Tata McGraw Hill)

Engineering Economics-II

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
Field Work/Assignments: 40 Marks
End-Sem Exam: 60 Marks

Course Outcomes (CO)

At the end of course

1. Students would understand how managerial decisions are based on economics
2. Students would learn about capital budgeting and planning
3. Students would understand the importance balance trade, monetary policies and exchange rates
4. Students would understand the importance of day to day budgeting and personal finances at early stage
5. Students would learn about start-up culture and economics
6. Students would get to know funding rounds which would help them to run their own start-ups

Unit I: **Managerial Economics** [**10 hrs]**

Nature and scope of Managerial Decisions, Objectives of firms, Techniques of analyses with special reference to econometric method, Analysis of demand pattern, demand forecasting, Production function and production planning, cost and product relationships, cost function, Break-even-point analysis, Pricing and price related policies, Labour productivities and wages, Optimization problems, Introductory aspects of capital budgeting, Selected case studies under Indian conditions.

Unit II: International Economics [7 hrs]

Balance of Trade and Balance of Payments, Barriers to Trade, Benefits of Trade/Comparative Advantage, Foreign Currency Markets/Exchange Rates, Monetary, Fiscal and Exchange rate policies, Economic Development

Unit III: Personal Economics [5 hrs]

Compound Interest and Credit, Financial Markets, Human Capital and Insurance, Money Management/Budgeting, Risk and Return, Saving and Investing

Unit IV: **Start – up Economics [6 hrs]**

Introduction to Start-up Finance, Introduction to Financial Terms, Financial Ratios, Capital Funding, VC's , Funding Rounds, Series A, B..

Text Books:

- Carton, D. and J.Perloff. Modern Industrial Organization (Reading, Massachusetts: Addison-Wesley), 1999.
- Hay, Donald A. and Derek J. Morris. Industrial Economics and Organization: Theory and Evidence, 2nd Edition (Oxford: Oxford University Press), 1991.
- Lall, Sanjaya. Competitiveness, Technology and Skills (Cheltenham: Edward Elgar), 2001.
- Scherer, F. M. and D. Ross. Industrial Market Structure and Economic Performance, 3rd Edition (Houghton: Mifflin), 1990.

Reference:

- Schmalensee, R., Inter-industry studies of Structure and Performance, in Schmalensee, R. and R. D. Willig (eds.): Handbook of Industrial Organization [Amsterdam: North-Holland] Vols. 2 Chapter 16, pp. 951-1009, 1989.
- Siddharthan, N. S. and Y.S. Rajan. Global Business, Technology and Knowledge Sharing: Lessons for Developing Country Enterprises (New Delhi: Macmillan), 2002.

Industrial Psychology-II

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
Field Work/Assignments: 40 Marks
End-Sem Exam: 60 Marks

Course Outcomes (CO)

At the end of course

1. Students would learn about major psychological factors involved in the process of employment
2. Students would acquire psychological skills required to sustain employability
3. Students would understand the elements of organizational culture for enhancing group/team behaviour
4. Students would understand the role of diversity in workforce and acknowledge the multicultural factors influencing workplace behaviour
5. Students would learn to apply the concepts of Engineering Psychology with respect to their disciplines
6. Students would learn about the impact of Psychological factors in consumer behaviour and role of conscious efforts needed in designing products
7. Students would demonstrate the knowledge gained through practical implementation

Unit 1: Managing People at Work [8 hrs]

Employee Selection- Techniques, Fair Employment Practices, Biographical Information, Interviews, References & Letters of Recommendation, Job Analysis- Types; Newer Developments, Performance Assessment: Evaluation & Appraisal- Objective & Subjective Techniques, Bias, Post Appraisal Interviews, Organizational Training- Types of Training, Psychological Issues; Career Development & Planning

Unit 2: Groups at Work [6 hrs]

Relationships- At workplace, Issues, Developing Effective Relationships, Groups & Teams- Stages of Group Development, Group Behaviour, Social Identity Theory, Leadership- New Approaches- Leader-Member Exchange, Transactional, Transformational & Charismatic Leaderships, Diversity at Workplace- Cultural Differences (Multiculturalism, Psychometric Testing, Motivation, Work-related Attitude, Leadership, Team work, etc.)

Unit 3: Engineering Psychology-II [8 hrs]

Workspace Designs- General Principles, Design of Standing & Seating Work Areas; Human Anthropometry- Structural & Functional Data, Use of Anthropometric Data in Design, Human Computer Interaction- Software Design Cycle, System & User Characteristics, Principles &

Guidelines for Design, Automation- Problems, Function Allocation; Transportation- Visibility, Hazards & Collisions, Characteristics of Impaired Driver, Safety Improvements, Industrial Robots

Unit 4: Consumer Psychology **[8 hrs]**

Scope & Research Methods- Surveys, Public Opinion Polls, Focus Groups, Observations of Shopping Behaviour, Neuromarketing, Advertising- Nature, Scope & Types, Consumer Behaviour & Motivation- Buying Habits, Product Pricing, Targeted Advertising, Visual Merchandising- Psychological Perspective- Techniques, Impulse Buying, Online Visual Merchandising

Text Books:

- Schultz, D. & Schultz, S. E. (2013). *Psychology and Work Today: An Introduction to Industrial and Organizational Psychology*. 7th Edition. Pearson Education: New Delhi.
- Matthewman, L., Rose, A. & Hetherington, A. (2009). *Work Psychology*. Oxford University Press: India.
- Wickens, C. D.; Lee, J. D., Liu, Y. & Gordon Becker, S. E. (2015). *An Introduction to Human Factors Engineering*. 2nd Edition. Pearson Education: New Delhi.

References:

- Landy, F. J. & Conte, J. M. (2010). *Work in the 21st Century: An Introduction to Industrial and Organizational Psychology*. 2nd Edition. Wiley India: New Delhi.
- Schultz, D. & Schultz, S. E. (2002). *Psychology and Work Today*. Pearson Education: New Delhi.

Personnel Psychology-II

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
Assignments: 60 Marks
End-Sem Exam: 40 Marks

Course Outcomes

At the end of the course

1. Students will understand importance of motivation.
2. Students will be able to realize importance of standards of behavior at work place.
3. Students will get guide lines to achieve workplace success.
4. Students will enable to manage stress and conflict in their personal life and at workplace.

Unit I: **[4 hrs]**

Motivation Self motivation and motivating others in their job

Unit II: **[4 hrs]**

Emotional Intelligence & values- Emotional intelligence and Standards of conducts

Unit III: **[8 hrs]**

Work place success - Setting goals, performance appraisal and moving ahead

Unit IV: **[6 hrs]**

Stress & conflict management at work place- Occupational stress and conflict, strategies for stress and conflict management

Text Books:

- Khana S.S. (2016) Organizational Behaviour(Text and Cases) Chand and company Pvt. Ltd. Delhi.
- Rae Andr'e (2008) organizational behavior. Dorling Kindersley (India) Pvt. Ltd.
- Wallace Hand Masters L.- (2008) Personality development..Cengage Learning India Pvt. Ltd.

Referece books:

- Robbins S, JudgeA, Vohra N (2013) Organizational behavior.(15th ed) Pearson Education,Inc.
- Singh Kavita (2010) Organizational behavior-Text and cases. Dorling Kindersley (India) Pvt. Ltd.

Japanese Language –II

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
Oral: 20 Marks
End-Sem Exam: 80 Marks

Course Outcomes (CO)

At the end of course

1. Students would be able to acquire target phrases and expressions
2. Students would master elementary Japanese grammar
3. Students would be able to converse about professions at work
4. Students would be familiar with the customs, work culture & society of Japan

Unit I: **[06 hrs]**

Formation of requests, asking for permission/prohibition,
speaking conversations of everyday life.

Unit II: **[06 hrs]**

Rules and prohibitions, expressing potential and hobbies, sharing experiences.

Unit III: **[06 hrs]**

Informal Conversations with friends, Expression of opinions, expectations,
Utilization of modifying forms

Unit IV: **[06 hrs]**

Vocabulary of Machines, Directions, Forms of verbs (give/take/receive),
Description of condition and coming to decision

Text book:

1. Minnano no Nihongo 1-2.Goyal Publishers& Distributors Pvt. Ltd. Delhi, India.

German Language -II

Teaching Scheme:
Lectures : 2 Hrs/week

Examination Scheme:
Oral: 20 Marks
End-Sem Exam: 80 Marks

Course Outcomes:

At the end of the course

1. Students would understand conversations of time and appointments
2. Students would be familiar with the place orientation and directions
3. Students would be able to converse about professions and schedules at work
4. Students would be familiar with the tourism and culture of German

Unit I **[07 hrs]**

Termine: (Appointments)

Termine und Verabredungen, Pünktlichkeit interkulturell, Texte: Meldebestätigung, Veranstaltungsangebote, Arztchild, Gedicht, Wortfelder: Uhrzeiten, Wochentage, Tageszeiten

Unit II: **[06 hrs]**

Orientierung: (Orientation)

Orientierung am Arbeitsplatz, Der Weg zur Arbeit, Die Stadt Leipzig/ Quiz online, Texte: Stadtplan, Etagenplan, Terminkalender, Prospekt, Wortfelder: Stadt, Verkehrsmittel, Büro und Computer

Unit III: **[05 hrs]**

Berufe: (Professions)

Beruf und Alltag, Texte: Visitenkarten, Wörterbuchauszüge, Wortfelder: Berufe und Tätigkeiten

Unit IV: **[06 hrs]**

Berlin sehen: (To see Berlin)

Eine Exkursion durch Berlin, Orientierung in der Stadt, Projekt ,,Internetrally''
Texte: Busplan, Stadtplan, Postkarte, Exkursionsprogramm, Wortfelder: Tourismus, Kultur

Text Book:

1. Funk, Kuhn, & Demme. Studio d A1. Deutsch als Fremdsprache. 2011. Goyal Publishers & Distributors Pvt. Ltd. Delhi, India

Internship

Teaching Scheme:
Industrial training: min 4 weeks

Examination Scheme:
ESE: 100 Marks

Course Outcomes:
At the end of course students will be able to

1. Design process to meet desired needs within realistic constraints such as social, ethical and manufacturability.
2. Understands the professional and ethical responsibility.
3. Handle the various projects with multidisciplinary teams.
4. Write technical report of assignment undertaken in industry

The students shall make minimum 3 visits related to metallurgical field. They will submit the visit report consisting of various aspects such as company's product, plant layout, new processes or methods adapted, role of metallurgist in the organization.
The students will undergo industrial training for the period between 4 to 6 weeks. The training may be completed within the summer or winter vacation. The training report will be submitted along with the training certificate from the company. The report should consist of assignment undertaken during training, company profile, products, layout and other relevant details.

Mini Project

Teaching Scheme:
Laboratory: 4 hrs/week

Examination Scheme:
Term work - 50 Marks
End-Sem exam - 50 Marks

Course Outcomes:
At the end of course students will be able to

1. Identify the problem definition of project by analysing the literature review.
2. Design the experiments and its setup to obtain the specific objective of project
3. Work in laboratory effectively and safely on multidisciplinary projects.
4. Communicate the technical information effectively in both verbal and written forms.

Project Work:
The students shall be assigned a small project, which will test their creativity in the area of design and development, setting of new experiments. It should form a part of literature and feasibility survey. The outcome of mini-project should preferably lead to a major project. Collection of samples for metallography laboratory, cold models concerned with metallurgical processes. Mini-project can be the stage-I of the major project where literature survey and experimental-planning for the major project will be the main goals. At the end of semester student shall submit a detail write-up on the project work undertaken by them including literature survey from reputed journals, proceedings, conferences, problem definition, objective of project, experimental planning/methodology. Evaluation will be on the basis of the attendance, set up created and seminars delivered/oral examination given by the students.

Non Ferrous Metallurgy Laboratory

Teaching Scheme:
Practical: 2hrs/Week

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

Course Outcome :

At the end of course students will be able to

1. Understand phase diagrams of Copper, Aluminium, Nickel, Magnesium and Titanium base alloys.
2. Classify different types of nonferrous alloys on the basis of microstructure.
3. Draw structure property relationship for various nonferrous alloys.
4. Interpret results of heat treatment given to nonferrous alloys.

List of Experiments:(Any eight)

1. Preparation of specimen of nonferrous alloys by electrolytic polishing and etching method.
2. To study phase diagrams of aluminium alloys and observe microstructure of cast and wrought aluminium alloys.
3. To study Cu-Zn phase diagram and observe the microstructure of brasses.
4. To study phase diagrams of Cu-Sn, Cu-Al, Cu-Ni,Cu-Si alloys and observe the microstructure of various bonzes.
5. To study the microstructure of Bearing alloys (Babbitts) and correlate structure properties relationship.
6. To study the precipitation hardening of aluminium alloys (2XXX,6XXX &7XXX)and Cu-Be bronze.
7. To study modification treatment of Al-Si alloys.
8. To study the heat treatment of titanium alloys.
9. To study heat treatment of magnesium alloys.
10. Colour Metallography of Nonferrous alloys.

Reference Books:

- Engineering Physical Metallurgy by Lakhtin , CBS Publisher
- Physical Metallurgy for Engineers – Donald S. Clark, & Wilbur R. Varney, CBS Publishers & Distributors, New Delhi
- Heat Treatment, Structure and Properties of Non-ferrous Alloys – Charlie R. Books, 1982, ASM.
- Introduction to Physical Metallurgy – Sidney H. Avner, McGraw-Hill Book Company, New Delhi

- Metals Handbook Ninth Edition – Vol.2, Properties and Selection: Non-ferrous alloys and Pure Metals, American Society for Metals, Metals Park, Ohio.
- Heat Treatment Principle and techniques – T V Rajan, C P Sharma, Ashok Sharma , Second Edition, PHI Publications.
- Light Alloys -I.J.Polmear, Butterworth Heinemann ,Third edition 1995

Foundry Technology

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

At the end of course students will be able to

1. Know basics of sand casting, mold making, pattern making and core making
2. Understand special molding and casting processes
3. Understand the fundamentals of melting furnaces used in foundry
4. Understand basics of solidification and importance of shakeout, cleaning, fettling, finishing and heat treatment of casting

Unit I: **[4 hrs]**

Basic sand casting process, pattern, mould, core, gating, riser, casting yield, Classification of casting processes, Types of Foundries, General layout and sections in foundries, Patterns and Cores – Selection of parting line, allowances on pattern, pattern materials, color coding, core plates, core-boxes – metallostatic pressure, design of core print, chaplets

Unit II: **[4 hrs]**

Mold making - Green sand moulding, dry sand moulding, molding sands, Properties of foundry sands and their testing, additives, Sand Control, core sands, mould compaction machines, Jolt, Jolt-squeeze, high pressure molding, sand slinger, refractory coatings, Venting, molding boxes, chills,roll of additives & technical terms in sand like total clay, active clay, latent clay, dead clay.

Unit III: **[6 hrs]**

Special molding and casting processes - CO_2-Silicate process, Core making- Introduction to modern core sand binders like,hot box, cold box, ester & Shell moulding, Evaporative Pattern (EPC) and Vacuum-sealed (V-) processes, Plaster mould, Ceramic mould, Investment casting, Die casting process – gravity die, pressure die, low pressure die and squeeze casting, Introduction to Mold & Core coatings, their significance in getting satisfactory casting quality, Testing of coatings.

Unit IV: **[9 hrs]**

Melting furnaces – Cupola and its types, Cupola charge calculations, chill testing of C.I., Rotary furnace, Induction furnace, Arc furnace, holding furnaces, inoculation, fluxes, degassing, use of vacuum, de-oxidation practices in steel and cast iron foundry, converters for SG iron making, effects of melt Fluidity and its testing, foundry refractory

Unit V: **[9 hrs]**

Solidification of metals and alloys, long freezing range and short freezing range alloys, Directional Solidification, Constitutional super-cooling, Segregation, Modes of solidification - planner, cellular, dendritic mode, Casting feeding – shrinkage, riser and chills, Cain's formula, NRL method, Inscribed circle method, modulus method, padding, Gating systems- fluid flow, Pressurized and non-pressurized gating systems, metal filtration, Software for casting process.

Unit VI: **[4 hrs]**

Shakeout, cleaning, fettling, finishing and heat treatment of casting, salvage of defective castings, Nature and causes of Casting defects, their remedial measures, Casting design, Quality control and assurance, Casting evaluation, statistical quality control, Inspection and testing of castings. Aluminium alloy, Magnesium alloy, copper alloy and special alloy foundry practice.

Text Books:

- P.L. Jain- Principles of Foundry Technology, 4thedition, Tata-McGraw-Hill, New Delhi, 2003.
- A.K. Chakrabarti, Casting Technology and cast alloys, Prentice-Hall of India, 2005.
- R.W. Hiene, C.R. Loper and P.C. Rosenthal, Principles of Metal Casting, Tata-McGraw-Hill, Reprint 1998.

Reference Books:

- Peter Beeley, Foundry Technology, 2ndedition, Butterworth-Heinemann, Oxford, 2001.
- ASM Handbook, Vol. 15, ASM International, OH, USA.

Structural Metallurgy

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

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

Course Outcomes:

At the end of course students will be able to

1. Understand fundamentals of dislocation theory and strengthening mechanisms of materials
2. Apply Fick's laws of diffusion to solve problems involving diffusion
3. Understand fundamentals of nucleation, growth and phase transformation kinetics
4. Know basics of creep phenomenon

Unit I: [7 hrs]

Dislocation Theory: Methods of Observation of Dislocations, Elastic Properties of Dislocations, Strain Energy of Dislocations, Forces On and Between Dislocations, Dislocations in FCC and other crystal structure, Climb and cross slip of Dislocations, Multiplication of Dislocations, Dislocation Pile Ups, Strengthening by Dislocations, Work Hardening.

Unit II: [7 hrs]

Strengthening Mechanisms: Strengthening by Grain Boundaries, dislocation model of small angle grain boundary, Yield Point Phenomenon, Strain Ageing, Solid Solution Strengthening, Strengthening from Fine Particles, Fiber Strengthening, Strengthening due to Point Defect.

Unit III: [7 hrs]

Diffusion in Solids: Types of diffusion, Fick's Laws of Diffusion, Solution of Fick's Laws and their Applications to various Metallurgical Processes-carburising, diffusion couples, semiconductors etc., Kirkendall Effect, Diffusion paths along grain boundaries and free surfaces.

Unit IV: [7 hrs]

Nucleation and Growth: The nucleation, growth and overall transformation kinetics, Homogeneous and Heterogeneous Nucleation , the glass transition, recovery, recrystallization and grain growth , Order-Disorder transformations-dislocations and stacking fault in ordered structure.

Unit V: [8 hrs]

Kinetics and Solid State phase transformation: Transformations in steels-Pearlitic and Bainitic transformation, Martensitic transformation-Bain distortion ,nature and multiplicity of habit planes, stabilization, Dimensional changes, Iron–Nickel martensitic transformation,Precipitation and Age Hardening - Study of Al-Cu system, Theories of Structural Changes during Aging

Unit VI: **[6 hrs]**

Creep resistant alloys: Creep Mechanism, creep curve, Relation between dislocation density and stress, Super plasticity, Shape Memory alloys.

Text Books:

- Dieter George E. - Mechanical Metallurgy, McGraw Hill. London, 1988.
- Robert Reed - Hill - Physical Metallurgy Principles, Thomson/Brooks/Cole,2005
- Hayden, Moffat and Wolff - The structure and Properties of Materials, Vol-III (Mechanical Behavior), Wiley Eastern Pvt. Ltd,1991
- V. Raghvan - Material Science and Engineering,PHI,2004
- V. Raghvan –Solid State phase Transformation, PHI, 2010.

Reference Books:

- Brophy, Rose and Wolff - Thermodynamics of Structure, Vol-II, Wiley Eastern Pvt. Ltd, New Delhi, 1964.
- Porter, Easter ling Sherif -Phase transformation in Metals and Alloys-CRC Press, 2009.
- Thomas H. Courtney-Mechanical Behavior of Materials-Waveland Press USA, 2005.

Steel Making

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:
At the end of course students will be able to

1. Identify various laws, phenomena and processes involved in making of steels.
2. Apply and explain physicochemical reactions that are taking place during oxidation and reducing period in steelmaking.
3. Analyze effect of input raw material, for example, scrap / hot metal and other raw materials including refractories on cleanliness of steel.
4. Evaluate impact of deoxidation, vacuum degassing and casting technology on production of sound casting s suited for forging / rolling purpose.
5. Design process route for making sound and clean steel

Unit I: **[6 hrs]**
History of Steel Making from Bessemer steel making to present day equipment and practices, Integrated and Mini Steel Plants in India, Indian steel scenario as at present and Principles guiding Steel Plant location.

Unit II: **[6 hrs]**
Physical Chemistry of Steel Making: Thermodynamic and Kinetics of Refining Reactions, Carbon Reaction, Phosphorus Reaction, Sulphur Reaction, Silicon Reaction, Refining Slags and its properties, Importance and Mechanism of Decarburization Reaction, Reaction at Slag Metal interface.

Unit III: **[6 hrs]**
Basic Oxygen Steel Making: BOF practice, Equipment, Operation and Process, slag Metal reactions in B.O.F.,Raw material and flux practices, Modifications and further Development in Conventional BOF, Oxygen Lance: Design, Construction and Operation, Top and Bottom Blow processes, its advantages and disadvantage

Unit IV: **[6 hrs]**
Electric Steel Making: Details of Electric Arc Furnaces, Its Variations, Sequence of EAF Operations, Various additions at Different Stages, Slag Control, UHP Arc Furnaces, Arc Furnace practices for Carbon and Low Alloy Steels

Unit V: **[6 hrs]**
Secondary Steel Making Processes, Ladle Furnaces (L.F.), Vacuum Systems and Vacuum treatment of Steel, Gases in steel, LF-VD processes and AOD, VOD, VAD techniques, R-H

degassers, Ladle Stirring and its Advantages, ESR-Principle and Technology, Deoxidation – Theory and practice, Floatation's of products, Modifications of Inclusions, Injection Metallurgy.

Unit VI: **[6 hrs]**

Continuous Casting (C.C.) and Ingot Casting, Ingot Casting: Types of Moulds, Advantages and Disadvantages, Ingot Defects and Remedies, Continuous casting: C.C. machines with its various units and types C.C. of Blooms, Slabs and Thin slabs EM S of Moulds, Reoxidation prevention methods during Steel Casting, Advantage of C.C. Environmental issues related to Steel Making.

Text Books:

- R. H. Tupkary, V. R. Tupkary, An introduction to modern Steelmaking, 7thEdition, Khanna Publications, Delhi, 2012.
- AhindraGhosh, AmitChatterjee Iron and Steel making: Theory and practice, 2ndEdition, PHI learning Pvt. Ltd, New Delhi, 2011.
- V. Kudrin, Steel Making, 1st edition, Mir Publisher, Moscow, 1985.

Reference Books:

- G.R. Bashforth- Manufacture of Iron and Steel, Vol. I & II, Asia Publishing House, Mumbai
- Darken and Gurry- Physical Chemistry of Metals, McGraw Hill, 1953.
- W.R. Irving, Continuous Casting, Maney Publishing, 1993.
- National Steel Policy (NSP), Ministry of Steel, Government of India, 2012.

Materials Characterization

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:
At the end of course students will be able to

1. Utilize the knowledge of optical microscope, electron microscope, thermal analysis techniques in analyzing the materials fully.
2. Analyze, interpret and present observations on the grain size of steels.
3. Prepare powder samples for transmission electron microscope.
4. Know the basic concept of x-ray diffraction and interpretation of XRD patterns. They will determine the lattice constant, crystal structure and type of phase.
5. Interpret thermogram obtained from TGA/DTA/ DSC/dilatometer etc.

Unit I: **[8 hrs]**
X-ray Diffraction: Production and properties of x-rays, Absorption of x-rays and filters, diffraction of X-rays through crystals. Bragg's law, structure factor calculations for simple, body centered, and face centered cubic crystal structures, Laue and Powder methods, Indexing of powder photographs, Determination of lattice parameters of cubic metals and alloys using powder method. Stereographic projection, some simple applications of X-rays to metallurgical problems such as determination of lattice strains, crystallite size, and residual stresses.

Unit II: **[8 hrs]**
Scanning electron microscope (SEM), interaction of electrons with matter, optics of SEM, image formation, resolving power, modes of operation, magnification, depth of focus, methods of specimen preparation, Applications of SEM.

Unit III: **[8 hrs]**
Transmission electron microscope (TEM), elements of electron optics, resolving power, image formation, contrast mechanism, bright field and dark field images, selected area diffraction, techniques of specimen preparation, and applications of TEM.

Unit IV: **[8 hrs]**
Micro-analysis by EDX, WDX, EELS, and EPMA, Surface analysis by XPS, Auger Electron Spectroscopy (AES), Scanning probe microscope: Scanning-Tunneling Microscope (STM) and Atomic Force Microscope (AFM).

Unit V: **[8 hrs]**

Thermal analysis techniques; Basic principles and applications of thermogravimetry analyzer (TGA)/differential thermogravimetry analysis (DTG), differential thermal analyzer (DTA), differential scanning calorimeter (DSC), dilatometer etc., Basic concept of electrical resistivity, effect of temperature, processing and strengthening on the resistivity of metals and alloys.

Text Books:

- P.E. Flewitt, R.K. Wild, Micro structural Characterization of Metals and Alloys, Institute of Metals, London, 1986.
- P.J. Goodhew, J. Humphreys, R. Beanland, Electron Microscopy and Analysis, 3rd Edition, Taylor and Francis, London.
- Edited by E. Metcalfe, Microstructure Characterization – The Institute of Metals, USA.
- B.D. Cullity, Elements of X-ray Diffraction (For X-rays), 3rd edition, Prentice-Hall, Upper Saddle River 2001.
- V. T. Cherepin and A.K. MalIik – Experimental techniques in Physical Metallurgy, Asia Publishing House.
- George L. Kehl - Principles of Metallographic Laboratory Practice - Eurasia Publishing house Pvt. Ltd. (For Dilatometry, Thermal analysis and resistivity).
- BL Gabriel - SEM - A Users Manual for Material Science - American Society for Metals.
- Thomas & M.T. Goringe, Transmission Electron Microscopy of Materials, John Wiley, 1979.
- L.E. Murr, Electron and Ion Microscopy and Microanalysis, Marcel Dekker, 1991.

Reference Books:

- ASM Metals Handbook, 9th Edition, Vol.10 - Materials Characterisation - ASM International Publication, 1980

Materials Characterization Laboratory

Teaching Scheme:
Laboratory: 2 hrs/week

Examination Scheme:
Continuous evaluation - 50 Marks
End Sem Exam - 50 Marks

Course Outcomes:
At the end of course students will be able to

1. Conversant with the know-how and the methodological tools for the characterization of materials.
2. Analyze particle size and grain size of materials.
3. Determine the electrical conductivity of the metals.
4. Determine the CTE of the metals, alloys and polymers using dilatometer.
5. Determine the lattice constant, crystal structure and type of phase using XRD patterns.

List of Experiments:

1. Grain size measurement by various techniques.
2. Determination of particle size using optical microscope.
3. Determination of resistivity of metal/alloy using digital multimeter.
4. Determination of conductivity of metals/alloys as per IACS standard.
5. Determination of crystal structure of metal or single phase alloy from X-ray diffraction (XRD) pattern.
6. Identification of an unknown specimen using XRD pattern.
7. Determination of crystallite size of nanomaterials using X-ray diffraction.
8. Determination of linear coefficient of thermal expansion (CTE) of materials using dilatometer.
9. Thermogram curves (TGA/DSC/DTA) of metal/alloys/polymers.
10. Numerical on X-ray diffraction techniques.
11. Surface morphology and Fractography by SEM.
12. Determination of % filler (or reinforcement) content in polymers using TGA.

Foundry Technology Laboratory

Teaching Scheme:
Laboratory: 2 hrs/week

Examination Scheme:
Continuous evaluation - 50 Marks
End Sem Exam - 50 Marks

Course Outcomes:
At the end of course students will be able to

1. Perform experiments on sand cleaning, conditioning and blending.
2. Determine AFS grain fineness number, moisture content, mouldability, flowability
3. Conduct fluidity test
4. Design experiments on pattern and core making
5. Conduct and interpret fluidity test

List of Experiments:

a) Sand testing:
    1) Sand cleaning, conditioning and blending.
    2) Sieve shaker, AFS grain fineness number.
    3) Moisture content, Mouldability, Flowability, Friability mold hardness.
b) Metal melting in crucible Muffle or Induction furnace, molten metal additions.
c) Pattern and core making, preparation of core sand and it's testing e.g. Hardness, Flowability, Mouldability, etc. Baking of cores in ovens.
d) Fluidity Test.
e) Visit to at least one foundry around Pune.

Courses for B.Tech Minor (Metallurgical Engineering)

Composite Materials

Teaching Scheme: **Examination Scheme:**

Lectures : 3 Hrs/week

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

Course outcomes:

- Introduce students the field of Composite Materials used in various engineering applications

Unit I: **[6]**

Composite materials in engineering, reinforcing materials: fibers, whiskers and particles. Fiber materials for composites, Fibers of glass, boron, carbon, organic, ceramic and metallic fibers, Matrix materials, Interfaces between matrix and fibers and other dispersed phases.

Unit II: **[6]**

Polymer matrix composites, Characteristics and applications, Fabrication of polymer matrix composites, Metal matrix composites (MMC), Fabrication of MMCs by liquid state, solid state methods, powder metallurgy route and in situ fabrication methods, Discontinuous reinforcement of MMCs, Ceramic matrix composites, Fabrication methods and applications.

Unit III: **[6]**

Mechanical properties in composites, large particle composites and the rule of mixtures for elastic constants, Mechanical properties of fiber reinforced composites, Effect of fiber length, Critical fiber length, Strength of continuous and aligned fiber composites, Discontinuous and aligned fiber composites, Toughening Mechanism, Impact Resistance, Fatigue and Environmental Effects.

Unit IV: **[6]**

Structural Composites: Cement matrix composites, Steel Reinforced Concrete, Prestressed concrete, Thermal Control, Vibration reduction. Polymer matrix composites- vibration damping.

Unit V: **[6]**

Composite materials for Electrical, Electromagnetic and Dielectric applications, Microelectronics and Resistance heating, Electrical insulation, capacitors, piezoelectric, ferroelectric functions, electromagnetic windows, solid electrolytes, microwave switching.

Unit VI: **[6]**

Composite materials for optical and magnetic applications, optical waveguide, optical filters and lasers, multilayer for magnetic applications.

Text Books:

- Principles of Materials Science and Engineering, William F. Smith, Third• Edition, 2002, McGraw-Hill
- Composite Materials: Engineering and Science, Matthews F.L., and Rawlings• R. D., 1999, Woodhead Publishing Limited, Cambridge England.
- Composite Materials-Functional Materials for Modern Technology, DDL• Chung, Springer- Verlag Publications London
- The nature and Properties of Engg. Materials, Jastrzebaski, John Wiley• & Sons, New York.

Reference Books:

- Composite Materials Handbook, Mel M. Schwartz (R), 2nd Edition, 1992,• McGraw-Hill, New York.
- Fundamentals of Fiber Reinforced Composite Materials, A. R. Bunsell, J.• Renard , 2005, IOP Publishing Ltd.
- Composite Materials Science and Engg., Chawla K.K., Second Edition, 1998,• Springer Verlag

Non Destructive Testing

Teaching Scheme:
Lectures : 3 Hr/week

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

Course outcomes:
At the end of course students will be able to

1. Understand basics principles behind all important NDTs
2. Select proper method of NDT for detection of given type of defect
3. Interpret results of ultrasonic testing and X-ray radiography
4. Interpret results of eddy current testing and Acoustic Emission Testing

Unit I: **[6 hrs]**

Introduction of NDTs: Non destructive testing and its comparison with destructive testing, role of NDT in quality control, visual optical methods, dye penetrant testing, basic principle, types and characteristics of dye, methods of application, developer, evaluation, advantages, limitations and applications of DPT

Unit II: **[6 hrs]**

Magnetic particle testing: Basic theory of magnetism, magnetization methods, magnetic particle testing equipment, testing procedures, method of demagnetization, magnetic particle medium- evaluations of indications, acceptance standards, advantages, limitations and applications.

Unit III: **[6 hrs]**

Eddy current testing: Basic principle, Faraday's law, Inductance, Lenz's law, self and mutual inductance, impedance plane, equipments, techniques used for ECT, advantages, limitations and applications.

Unit IV: **[6 hrs]**

Radiography: Basic principles, electromagnetic radiation sources, effect of radiation in film, radiographic imaging, image formation, image quality, digital radiography, image interpretation, radiation shielding, inspection equipments and techniques, precaution against radiation hazards, advantages, limitations and applications.

Unit V: **[6 hrs]**

Ultrasonic Testing: Principle of operation, basics of ultrasonic waves, pulse and beam shapes, ultrasonic transducers, equipments and testing procedures, type of display, method of evaluation of discontinuities, identification of defects, advantages, limitations and applications

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Unit VI: **[6 hrs]**

Acoustic Emission Testing (AET): Basic principles, sources of acoustic emission, source parameters, Kaiser-Felicity theory, technique, instrumentation and applications, miscellaneous tests.

Text Books:

- Baldev Raj, T. Jayakumar, M. Thavasimuthu, Practical Non-Destructive Testing, 3rd Ed., Narosa.
- J. Prasad , C.G.K. Nair, Non Destructive Testing and Evaluation of Materials, Tata MacGraw Hill

Reference Books:

- Baldev Raj, T. Jayakumar, M. Thavasimuthu, Practical Non-Destructive Testing, 3rd Ed., Narosa.
- J. Prasad , C.G.K. Nair, Non Destructive Testing and Evaluation of Materials, Tata MacGraw Hill
- B. Hull, Non Destructive Testing, Springer.
- ASM Metals Handbook, Non Destructive Evaluation and Quality Control, Vol. 17, 9th Ed.
- Louis Cartz, Nondestructive Testing, ASM International

Bio-materials

Teaching Scheme:
Lectures : 3 Hr/week

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

Course outcomes:
At the end of course students will be able to

1. Understand structure properties relationship of biomaterials
2. Understand selection of biomaterials for a particular application
3. Understand mechanical properties of biomaterials 22
4. Understand biocompatibility of the materials for the intended application.

Syllabus Contents:
Structure and property relationships of different classes of biomaterials; Interactions of materials with the human body, Classification of Biomaterials, Composite materials and applications; Nanostructured biomaterials, Criteria for selection of biomaterials for specific medical applications, Concepts of Biocompatibility, Evaluation of biocompatibility, mechanical properties of biomaterials, corrosion and biodegradation, simulated body fluids and their effect on biodegradation, Orthopedic implants, dental materials, vascular grafts, ocular materials, drug delivery carriers, introduction to tissue regeneration scaffolds.

Text Books/Reference Books:

- Biomaterials Science: An Introduction to Materials in Medicine, 3rd Edition, Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons, 2013, Academic press, UK.
- Biomaterials, Medical Devices & Tissue Engineering: An integrated approach. Fredrick H. Silver, 1994, Chapman & Hall, UK.

Fracture and Failure of Engineering Materials

Teaching Scheme:
Lectures : 3 Hr/week

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

Course outcomes:

- Students will make aware of the failure mechanisms involved in the service of engineering components and devices.

Unit I: **[6 hrs]**

Failure mode, failure modes observed in practice, failure analysis and methodology, tools and techniques of failure analysis, failure experience matrix, Procedural steps involved in failure investigations.

Unit II: **[6 hrs]**

Basics of fracture mechanics, linear elastic and elastic – plastic fracture mechanics, experimental determination of fracture toughness, design using fracture mechanics.

Unit III: **[6 hrs]**

Fatigue failures ,cyclic stress and strain controlled fatigue, fatigue life estimation, micro structural aspects of fatigue failure, use of fracture mechanics, fatigue life improvement.

Unit IV: **[6 hrs]**

Elevated temperature failures, creep mechanisms, creep life estimation, deformation mechanism map, creep resistant materials.

Unit V: **[6 hrs]**

Wear failures, Abrasive and adhesive wear, wear mechanism map, materials having high wear resistance

Unit VI: **[6 hrs]**

Failure mechanisms in electronic materials and devices, nature of failure mechanisms investigations, approaches to achieving high reliability

Reference Books:

- A.K.Das - Metallurgy of Failure Analysis, TaTa McGraw Hill Publishing Company Limited ,New Delhi, 1996
- J.A. Charles, F.A.A. Crane and J.A.G. Furness - Selection and use of Engineering Materials, Third edition, Reed Educational and Professional Publishing ltd, 1997,

- George Dieter Mechanical Metallurgy, TaTa Mc Graw Hill Publications, London 1988. Materials Science and Technology for Design Engineers Edited by Alex E. Javitz, Hayden Book Company, India, 1979

Annexure I

List of Open Elective/Professional Science courses offered by ALL Departments

Sr. No	Department	Course
1	Civil	Finite Elements in Engineering
2	Mechanical	• Unconventional Machining Processes • Modern Control Systems • Power Plant Engineering
3	Electrical	• Industrial Drives • Control System Engineering
4	Electronics and Telecommunication	• Electronic Communication Systems
5	Metallurgy and Material Science	• Composite Materials
6	Instrumentation and Control	• Industrial Automation
7	Production	• Introduction to ERP • Operations Efficiency
8	Computer Engineering	• Information Systems
9	Information Technology	• Information Systems
10	Applied Science	• Humanities Course • Constitution of India
11	Innovation Centre	• Liberal Learning Course

Annexure II

List of Liberal Learning courses offered at Institute Level

- **Agricultural** – Animal Science, Forestry, Horticulture, Floriculture, Sustainable Agriculture, Veterinary
- **Arts** – Graphic Design, Interior Design, Fashion Design
- **Basic Sciences** – Astronomy, Astro-Physics, Biology, Genetics, Kinesiology, Microbiology, Neuro Sciences.
- **Business** – Administration, Communication, Entrepreneurial studies, Hostel Management, Marketing.
- **Defence Studies** - Military Studies, Naval Studies, Air Force Studies, War strategies.
- **Education** - Education policies, Engineering Education, Teacher Training.
- **Environmental Sciences** – Ecology, Meteorology
- **Linguistics** – Word Language
- **Medicine** – Health Studies Nutrition and dietetics
- **Performing Arts**- Music, Dance Theatre, Cinema
- **Philosophy**- Religious Studies
- **Sports and Athletics**