

GOVERNMENT OF ANDHRA PRADESH



STATE BOARD OF TECHNICAL EDUCATION AND TRAINING
Andhra Pradesh :: Amaravathi



Globally Competitive
CURRICULUM (C-16)
For Polytechnic Diploma Courses
In Andhra Pradesh



DIPLOMA IN
METALLURGICAL ENGINEERING

Front Cover Page

Objective of the New Curriculum (C-16)

To make the students 'Globally Competitive & Employable' by learning industry relevant subjects & undergoing Industrial training



Suggestions from Industrialists have been incorporated in the Curriculum by organising Industry Institute Interaction Meet.



Highlights of the Curriculum (C-16)



- ❖ 6 months /1 year industrial training in all the Diploma Courses.
- ❖ 1 year industrial training in collaboration with BOAT (Board of Apprenticeship & Training (SR), Chennai).
- ❖ Virtual labs for ECE & Computer Branches & Strengthening of Skill Development Centers to provide industrial training to students.

Fundamentals of 'Internet of Things' (IoT) is included for all the Branches in the Subject "Industrial Management & Smart Technologies".



"Communication Skills" and "Life Skills" have been introduced as practical subjects for all the Branches.





“Computer Fundamentals Laboratory” is introduced for all the Branches in First year. AutoCAD specific to the Branch has been given emphasis in the Curriculum.

C Language, Programmable Logic Controllers (PLC), Microcontrollers, Solar Energy are introduced in Electrical Engineering Branch.



Mobile Communications, Consumer Electronics are introduced in Electronics and Communication Branch

CAD/ CAM, CNC Machines, Power Plant Engineering are introduced in Mechanical Engineering Branch.



OOPS through JAVA, Web Designing, Computer Hardware & Networking are introduced in Computer Engineering Branch.

Automobile Chassis and Body Engineering, Recent Trends In Automobile Engineering, Motor Transport Organization etc are introduced in Automobile Engineering Branch.



Journal (JPAP)

The Department of
Technical Education,
A.P. has a bi- annual
'Journal of Polytechnics
of Andhra Pradesh'
JPAP



JOURNAL OF POLYTECHNICS IN ANDHRA PRADESH
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FACULTY

1. COMPETITION AND LAYOUT EXTRACTION OF SBF DECODER FOR BINARY LOGIC CODES 1-10
Dr. C. Chandra Reddy
2. INFLUENCE OF NYLON FIBER REINFORCEMENT ON LIME STABILIZED CLAYEY SOIL 11-18
Dr. P. Srinivasa Raju
3. ANALYSIS OF COLOUR IMAGE PROCESSING USING SPATIAL FILTER TECHNIQUES 19-26
Dr. O. Subrahmanyam, P. Kumar Babu
4. ASSESSMENT OF SEISMIC VULNERABILITY OF REINFORCED CONCRETE BUILDING FRAMES USING PUSHOVER ANALYSIS 27-38
T. P. Dasasubramaniam, Ravinimal Varma

STUDENT

5. STUDY OF ADVANCED DIGITAL MODULATION TECHNIQUES USING MATLAB 39-48
Bhadrakali Mahesh Rao, Kulkarnigadde Diva Raju, Marudula Rajashekar
6. IMPLEMENTATION OF PHASE LOCKED LOOP BY USING CLOSED LOOP SYSTEM 49-57
Poggaravaru Sandhya, Pattajala Maheswari, Shanki Dhalesara
7. CNC MILLING PROCESS CAPABILITY -A CASE STUDY 58-64
S. Kani Viswanath, B. Krasithi Bhargava, Dr. N. Chandan Shekhar
8. SELECTION OF A CAR THROUGH MULTIPLE CRITERIA DECISION MAKING (MCDM) APPROACH 65-68
T. Sarath, Y. Raja Babu, K. S. S. Phani, A. Ravi Kumar
9. MODEL OF AN LIFT PUMP 67-68
Shanki Maheshwari
10. MEASUREMENT SYSTEM ANALYSIS-AN ILLUSTRATIVE EXAMPLE 69-75
B. Manoj Kumar, Ch. V. Prasad, T. Balasubrahmaniam, M. Srinivas, M. A. Qadiri, K. Mahalingam Rao, K. Hanumanth Rao, M. Sankarajayalaxmi

INDUSTRY

11. SELF ASSESSMENT OF IS IN A SMALL AND MEDIUM ENTERPRISE -A CASE STUDY 76-81
V. Ramesh Babu, Pooja Sarathi, S. V. Ramana, Dr. B. Nagaraj Rao



CISCO ACADEMIES IN POLYTECHNICS

- ◆ 70 Government Polytechnics chosen to have Cisco Academies
- ◆ Course Content of CISCO has been incorporated into the ECE and Computer Diploma Courses
- ◆ CISCO to train Staff of Polytechnics in two phases to enable them to run the courses effectively
- ◆ Students to get 'Certificate from CISCO' along with Diploma Certificate.

CURRICULUM-2016

(C-16)

3 ½ YEAR

DIPLOMA IN

METALLURGICAL ENGINEERING



STATE BOARD OF TECHNICAL EDUCATION & TRAINING

ANDHRA PRADESH

HYDERABAD

**3 ½ YEAR (SW) DIPLOMA IN
METALLURGICAL ENGINEERING
CURRICULUM-2016 (C-16)**

CONTENTS

S.No	Content	Page No.
1	Preamble	
2	Rules and Regulations	
3	Scheme of Instructions & Examination -I year	
4	Scheme of Instructions & Examination -III Sem	
5	Scheme of Instructions & Examination -IV Sem	
6	Scheme of Instructions & Examination -V Sem &VI Sem	
7	Scheme of Instructions & Examination -VII Sem	

CURRICULUM-2016
(C-16)

FOR DIPLOMA COURSES IN ANDHRA PRADESH

PREAMBLE

The State Board of Technical Education and Training, Andhra Pradesh under the aegis of the Department of Technical Education, Andhra Pradesh generally reviews the Curricula once in every five years. However, recognizing the needs of the industries and enhancing the employability skills of Polytechnic students, the Government of Andhra Pradesh constituted a committee vide G.O.Rt.No:95 of Higher Education (TE) Dept dated: 29-4-2016 and G.O.Rt.No:98 of Higher Education (TE) Dept dated: 4-5-2016 for updation of polytechnic curriculum under the chairmanship of Sri. S. Balasubrahmanyam, IAS (Retd.,). The committee submitted a report on 31-5-2016 making certain recommendations and suggesting new initiatives to be incorporated in the curriculum. An Industry Institute Interaction Meet was organized with Industry experts and subject experts on 26-12-2016 and the suggestions from Industrialists have also been incorporated in the curriculum. The new Curricula for the different diploma courses have been designed with the active participation of the members of the faculty teaching in the Polytechnics of Andhra Pradesh, besides reviewed by Expert Committee constituted with eminent academicians.

The primary objective of the curricular change is to produce best technicians in the country by correlating growing needs of the industries with the academic input.

The revised New Curriculum i.e., Curriculum–2016 (C-16) is approved by BoG of SBTET for its implementation with effect from 2016-17.

Salient Features:

1. Duration of course is either 3 years / 3½ years duration of Regular Academic Instruction.
2. The Curriculum is prepared in Semester Pattern. However, First Year is maintained as Year-wise pattern.
3. 6 Months/ 1 year Industrial Training is introduced for all the Diploma courses.
4. Fundamentals of Internet of Things (IOT) is introduced for all the Diploma courses in the subject.

5. Modern subjects relevant to the industry are introduced in all the Diploma courses.
6. CISCO course content has been incorporated into the ECE and CME courses to get certification from CISCO along with Diploma.
7. The policy decisions taken at the State and Central level with regard to environmental science are implemented by including relevant topics in Chemistry. This is also in accordance with the Supreme Court guidelines issued in Sri Mehta's case.
8. Keeping in view the increased need of communication skills which is playing a major role in the success of Diploma Level students in the Industries, emphasis is given for learning and acquiring listening, speaking, reading and writing skills in English. Further as emphasized in the meetings, Communication Skills lab and Life Skills lab are introduced for all the branches.
9. Modern topics relevant to the needs of the industry and global scenario suitable to be taught at Diploma level are also incorporated in the curriculum.
10. AutoCAD specific to the branch has been given more emphasis in the curriculum. Preparing drawings using CAD software has been given more importance.
11. Every student is exposed to the computer lab at the 1st year itself in order to familiarize himself with skills required for keyboard/mouse operation, internet usage and e-mailing.
12. Upon reviewing the existing C-14 curriculum, it is found that the theory content is found to have more weightage than the Practical content. In the revised C-16 curriculum, more emphasis is given to the practical content of Laboratories and Workshops, thus strengthening the practical skills.
13. With increased emphasis for the student to acquire Practical skills, the course content in all the subjects is thoroughly reviewed and structured as outcome based than the conventional procedure based.
14. Curricula of Laboratory and Workshops have been thoroughly revised based on the suggestions received from the industry and faculty, for better utilization of the equipment available at the Polytechnics. The experiments /exercises that are chosen for the practical sessions are identified to conform to the field requirements of industry.
15. The Members of the working group are grateful to Sri G.S. Panda Das, I.A.S., Special Commissioner of Technical Education & Chairman of SBTET, AP. and Sri. Adityanath Das, I.A.S., Principal Secretary of Higher Education for their guidance and valuable inputs in revising, modifying and updating the curriculum.
16. The Members acknowledge with thanks the cooperation and guidance provided by Sri. A.Nirmal Kumar Priya, Secretary, SBTET, Andhra Pradesh and other officials of Directorate of Technical Education and the State Board of Technical Education, Andhra Pradesh, experts from industry, academia from the universities and higher learning institutions and all teaching fraternity from the Polytechnics who are directly or indirectly involved in preparation of the curricula.

RULES AND REGULATIONS

1 DURATION AND PATTERN OF THE COURSES

All the Diploma programs run at various institutions are of AICTE approved 3 years or 3½ years duration of academic instruction.

All the Diploma courses are run on year wise pattern in the first year, and the remaining two or two & half years are run in the semester pattern. In respect of few courses like Diploma in BM course, the training will be in the seventh semester. Run-through system is adopted for all the Diploma Courses, subject to eligibility conditions.

2 PROCEDURE FOR ADMISSION INTO THE DIPLOMA COURSES:

Selection of candidates is governed by the Rules and regulations laid down in this regard from time to time.

- a) Candidates who wish to seek admission in any of the Diploma courses will have to appear for Common Entrance Test for admissions into Polytechnics (POLYCET) conducted by the State Board of Technical Education and Training, Andhra Pradesh, Vijayawada.

Only the candidates satisfying the following requirements will be eligible to appear for the Common Entrance Test for admissions into Polytechnics (POLYCET).

- b) The candidates seeking admission should have appeared for S.S.C examination, conducted by the Board of Secondary Education, Andhra Pradesh or equivalent examination thereto, at the time of making application to the Common Entrance Test for admissions into Polytechnics (POLYCET). In case of candidates whose results of their Qualifying Examinations is pending, their selection shall be subject to production of proof of their passing the qualifying examination in one attempt or compartmentally at the time of admission
- c) Admissions are made based on the merit obtained in the Common Entrance Test (POLYCET) and the reservation rules stipulated by the Government of Andhra Pradesh from time to time.
- d) For admission into the following Diploma Courses for which entry qualification is 10+2, candidates need not appear for POLYCET. A separate notification will be issued for admission into these courses.
1). D.H.M.C.T. 2).D. Pharmacy

3 MEDIUM OF INSTRUCTION

The medium of instruction and examination shall be English.

4 PERMANENT IDENTIFICATION NUMBER (PIN)

A cumulative / academic record is to be maintained of the Marks secured in sessional work and end examination of each year for determining the eligibility for

promotion etc., A Permanent Identification Number (PIN) will be allotted to each admitted candidate to maintain academic records.

5 NUMBER OF WORKING DAYS PER SEMESTER / YEAR:

- a). The Academic year for all the Courses shall be in accordance with the Academic Calendar.
- b). The Working days in a week shall be from Monday to Saturday
- c). There shall be 7 periods of 50 minutes duration on all working days.
- d). The minimum number of working days for each semester / year shall be 90 / 180 days excluding examination days. If this prescribed minimum is not achieved due to any reason, special arrangements shall be made to conduct classes to cover the syllabus.

6 ELIGIBILITY OF ATTENDANCE TO APPEAR FOR THE END EXAMINATION

- a). A candidate shall be permitted to appear for the end examination in all subjects, if he or she has attended a minimum of 75% of working days during the year/Semester.
- b). Condonation of shortage of attendance in aggregate upto 10% (65% and above and below 75%) in each semester or 1st year may be granted on medical grounds.
- c). A stipulated fee shall be payable towards condonation for shortage of attendance.
- d). Candidates having less than 65% attendance shall be detained.
- e). Students whose shortage of attendance is not condoned in any semester / 1st year and not paid the condonation fee in time are not eligible to take their end examination of that class and their admissions shall stand cancelled. They may seek re-admission for that semester / 1st year when offered next.

7 READMISSION

Readmission shall be granted to eligible candidates by the respective Principal/ Regional Joint Director.

1. a) Within 15 days after commencement of class work in any semester (Except Industrial Training).
- b) For Industrial Training: before commencement of the Industrial training.
2. Within 30 days after commencement of class works in any year (including D. Pharmacy course or first year course in Engineering and Non Engineering Diploma streams).

Otherwise such cases shall not be considered for readmission for that semester / year and are advised to seek readmission in the next subsequent eligible academic year.

The percentage of attendance of the readmitted candidates shall be calculated from the first day of beginning of the regular class work for that year / Semester, as officially announced by CTE/SBTET but not from the day on which he/she has actually reported to the class work, after readmission is granted.

8 SCHEME OF EXAMINATION

a) First Year

THEORY EXAMINATION: Each Subject carries 80% marks with examination of 3 hours duration, along with 20% marks for internal evaluation. (Sessional marks). However, there are no minimum marks prescribed for sessionals.

PRACTICAL EXAMINATION: There shall be 40% Marks for regular practical work done, i.e. sessional marks for each practical subject with an end examination of 3 hours duration carrying 60% marks. However, there are no minimum marks prescribed for sessionals.

b) III, IV, V, VI and VII Semesters:

THEORY EXAMINATION: Each subject carries usually 80 marks and 30 marks in respect of specified subjects of 3hours duration, along with 20 marks for internal evaluation (sessional marks) respectively.

PRACTICAL EXAMINATION: Each subject carry 60/30 marks of 3hours duration 40/20 sessional marks.

9 INTERNAL ASSESSMENT SCHEME

- a) Theory Subjects: Theory Subjects carry 20% sessional marks, Internal examinations will be conducted for awarding sessional marks on the dates specified. **Three unit tests will be conducted for I year students and two Unit Tests for semesters.** Average of marks obtained in all the prescribed tests will be considered for awarding the sessional marks.
- b) Practical Subjects: Student's performance in Laboratories / Workshop shall be assessed during the year/ semester of study for 40% marks in each practical subject. Allotment of marks should be discrete taking into consideration of the students' skills, accuracy, recording and performance of the task assigned to him / her. Each student has to write a record / log book for assessment purpose. In the

subject of Drawing, which is also considered as a practical paper, the same rules hold good. Drawing exercises are to be filed in seriatum.

- c) Internal assessment in Labs / workshops / Survey field work etc., during the course of study shall be done and sessional marks shall be awarded by the concerned Lecturer / Senior Lecturer / Workshop superintendent as the case may be.
- d) For practical examinations, except in drawing, there shall be two examiners. External examiner shall be appointed by the Principal in consultation with respective Head of Section preferably choosing a qualified person from any local Industry/ nearby Government Polytechnic/ Local Government Organization. Internal examiner shall be the person concerned with internal assessment as in (c) above. The end examination shall be held along with all theory papers in respect of drawing.
- e) Question Paper for Practicals: Question paper should cover all the experiments / exercise prescribed.
- f) Records pertaining to internal assessment marks of both theory and practical subjects are to be maintained for official inspection.
- g) **In case of Diploma courses *having* Industrial Training**, the training assessment shall be done and the marks are to be awarded in the following manner.

Industrial assessment	:	200 marks (in two spells of 100 marks each)
Maintenance of log book	:	30 marks
Record Work	:	30 marks
Seminar / viva-voce	:	40 marks

TOTAL	:	300 marks

The assessment at the institution level (Seminar/Viva-voce) shall be done by three members, viz., Internal Faculty member, External Examiner and Head of Section and be averaged.

10 **MINIMUM PASS MARKS**

THEORY EXAMINATION:

For passing a theory subject, a candidate has to secure a minimum of 35% in end examination and a combined minimum of 35% of both Sessional and end examination marks put together.

PRACTICAL EXAMINATION:

For passing a practical subject, a candidate has to secure a minimum of 50% in end examination and a combined minimum of 50% of both sessional and practical end examination marks put together. In case of D.C.C.P., the pass mark for typewriting and short hand is 45% in the end examination. There are no sessional marks for typewriting and Shorthand subjects of D.C.C.P course.

11. PROVISION FOR IMPROVEMENT

1. Improvement is allowed only after he / she has completed all the subjects from First Year to Final semester of the Diploma.
2. Improvement is allowed in any 4 (Four) subjects of the Diploma.
3. The student can avail of this improvement chance **ONLY ONCE**, that too within the succeeding two examinations after the completion of Diploma. However, the duration including Improvement examination shall not exceed **FIVE** years from the year of first admission.
4. No improvement is allowed in Practical / Lab subjects or Project work or Industrial Training assessment. However, improvement in drawing subject(s) is allowed.
5. If improvement is not achieved, the marks obtained in previous Examinations hold good.
6. Improvement is not allowed in respect of the candidates who are punished under Mal-practice in any Examination.
7. Examination fee for improvement shall be paid as per the notification issued by State Board of Technical Education and Training from time to time.
8. All the candidates who wish to appear for improvement of performance shall deposit the original Marks Memos of all the years / Semesters and also original Diploma Certificate to the Board. If there is improvement in performance of the current examination, the revised Memorandum of marks and Original Diploma Certificate will be issued, else the submitted originals will be returned.

12. RULES OF PROMOTION FROM 1ST YEAR TO 3rd, 4th, 5th, 6th and 7th SEMESTERS:

a) For Diploma Courses of 3 Years duration

- i. A candidate shall be permitted to appear for first year examination provided he / she puts in 75% attendance (which can be condoned on Medical grounds upto 10%) i.e. attendance after condonation on Medical grounds should not be less than 65% and pay the examination fee.
- ii. A candidate shall be promoted to 3rd semester if he/she puts the required percentage of attendance in the first year and pays the examination fee. A candidate who could not pay the first year examination fee has to pay the promotion fee as prescribed by State

Board of Technical Education and Training from time to time before commencement of 3rd semester.

- iii. A candidate shall be promoted to 4th semester provided he/she puts the required percentage of attendance in the 3rd semester and pay the examination fee. A candidate who could not pay the 3rd semester exam fee, has to pay the promotion fee as prescribed by State Board of Technical Education and Training from time to time before commencement of 4th semester.

A candidate is eligible to appear for the 4th semester examination if he/she

- i) Puts the required percentage of attendance in the 4th semester
- ii) Should not have failed in more than Four backlog subjects of 1st year

For IVC & ITI Lateral Entry Students:

A candidate is eligible to appear for the 4th semester examination if he/she puts the required percentage of attendance in the 4th semester

- iv) A candidate shall be promoted to 5th semester provided he / she puts the required percentage of attendance in the 4th semester and pays the examination fee. A candidate, who could not pay the 4th semester examination fee, has to pay the promotion fee as prescribed by State Board of Technical Education and Training from time to time before commencement of 5th semester.

A candidate is eligible to appear for the 5th semester examination if he/she

- i) Puts the required percentage of attendance in the 5th semester
- ii) Should get eligibility to appear for 4th Semester examination.

For IVC& ITI Lateral Entry students:

- i) Puts the required percentage of attendance in the 5th semester
- ii) Should not have failed in more than Four backlog subjects of 3rd Semester

- v) A candidate shall be promoted to 6th semester provided he/she puts in the required percentage of attendance in the 5th semester and pay the examination fee. A candidate who could not pay the 5th semester examination fee, has to pay the promotion fee as prescribed by State Board of Technical Education and Training from time to time before commencement of 6th semester.

A candidate is eligible to appear for 6th semester Industrial Training assessment (Seminar/Viva-voce)

- i) Puts the required percentage of attendance, ie., 90% in 6th semester Industrial Training
- ii) Should get eligibility to appear for 4th Semester Examination.

For IVC & ITI Lateral Entry students:

- i) Puts the required percentage of attendance, ie., 90% in 6th semester Industrial Training.
- ii) should get eligibility to appear for 5th Semester Examination.

Important Note:

Seminar/Viva-voce should not be conducted for Not-Eligible Candidates, till the candidate gets eligibility. The record of internal assessment for Industrial Training for 260 marks shall be maintained at Institution Level for all candidates and the data is to be uploaded only for eligible candidates. For not eligible candidates the data is to be uploaded as and when the candidate gets eligibility.

b) For Diploma Courses of 3 ½ Years duration (MET/ CH/ CHPP/ CHPC/ CHOT/ TT):

1. A candidate shall be permitted to appear for 1st year examination provided he / she puts in 75% attendance (which can be condoned on Medical grounds upto 10%) i.e. attendance after condonation on Medical grounds should not be less than 65% and pay the examination fee.
2. A candidate shall be promoted to 3rd semester if he/she puts the required percentage of attendance in the 1st year and pays the examination fee. A candidate who could not pay the 1st year examination fee has to pay the promotion fee as prescribed by State Board of Technical Education and Training from time to time before commencement of 3rd semester.
3. A candidate shall be promoted to 4th semester provided he/she puts the required percentage of attendance in the 3rd semester and pay the examination fee. A candidate, who could not pay the 3rd semester exam fee, has to pay the promotion fee as prescribed by State Board of Technical Education and Training from time to time before commencement of 4th semester.
A candidate is eligible to appear for the 4th semester exam if he/she
 - i) Puts the required percentage of attendance in the 4th semester
 - ii) Should not have failed in more than Four backlog subjects of 1st year.

For IVC & ITI Lateral Entry students:

- (i) Puts the required percentage of attendance in the 4th semester

4. A candidate shall be promoted to 5th semester industrial training provided he / she puts the required percentage of attendance in the 4th semester and pays the examination fee. A candidate, who could not pay the 4th semester examination fee, has to pay the promotion fee as prescribed by State Board of Technical Education and Training from time to time before commencement of 5th semester.
5. Promotion from 5th to 6th semester is automatic (i.e., from 1st spell of Industrial Training to 2nd spell) provided he/she puts the required percentage of attendance, which in this case ie.,90 % of attendance and attends for the VIVA-VOCE examination at the end of training.
6. A candidate shall be promoted to 7th semester provided he / she puts the required percentage of attendance in the 6th semester and pays the examination fee. A candidate, who could not pay the 6th semester examination fee, has to pay the promotion fee as prescribed by State Board of Technical Education and Training from time to time before commencement of 7th semester.
7. A candidate shall be promoted to 7th semester of the course provided he/she has successfully completed both the spells of Industrial Training.

A candidate is eligible to appear for 7th semester examination if he/she

- i) Puts the required percentage of attendance in the 7th semester
- ii) Should get eligibility to appear for 4th semester Examination.

For IVC & ITI Lateral Entry students:

- i) Puts the required percentage of attendance in the 7th semester
- ii) Should not have failed more than four backlog subjects of 3rd Semester

OTHER DETAILS

- a) In case a candidate does not successfully complete the Industrial training, he / she will have to repeat the training at his / her own cost.
- b) The I spell of Industrial training shall commence 10 days after the completion of the last theory examination of 4th Semester.
- c) The Second spell of Industrial training shall commence within 10 days after the completion of I spell of Industrial training.

c) For Diploma Courses of 3 ½ Years duration (BM):

The same rules which are applicable for conventional courses also apply for this course. The industrial training in respect of this course is restricted to one semester (6 months) after the 6th semester (3 years) of the course.

1. A candidate shall be permitted to appear for first year examination provided he / she puts in 75% attendance (which can be condoned on Medical grounds upto 10%) i.e. attendance after condonation on Medical grounds should not be less than 65% and pay the examination fee.
2. A candidate shall be promoted to 3rd semester if he/she puts the required percentage of attendance in the first year and pays the examination fee. A candidate who could not pay the first year examination fee has to pay the promotion fee as prescribed by State Board of Technical Education and Training from time to time before commencement of 3rd semester.
3. A candidate shall be promoted to 4th semester provided he/she puts the required percentage of attendance in the 3rd semester and pay the examination fee. A candidate who could not pay the 3rd semester examination fee, has to pay the promotion fee as prescribed by State Board of Technical Education and Training from time to time before commencement of 4th semester.

A candidate is eligible to appear for the 4th semester examination if he/she

- i) Puts the required percentage of attendance in the 4th semester
- ii) Should not have failed in more than Four backlog subjects of 1st year

For IVC & ITI Lateral Entry Students:

A candidate is eligible to appear for the 4th semester examination if he/she puts the required percentage of attendance in the 4th semester

4. A candidate shall be promoted to 5th semester provided he / she puts the required percentage of attendance in the 4th semester and pays the examination fee. A candidate, who could not pay the 4th semester examination fee, has to pay the promotion fee as prescribed by State Board of Technical Education and Training from time to time before commencement of 5th semester.

A candidate is eligible to appear for the 5th semester exam if he/she

- i) Puts the required percentage of attendance in the 5th semester
- ii) Should get eligibility to appear for 4th Semester examination.

For IVC & ITI Lateral Entry students:

- iii) Puts the required percentage of attendance in the 5th semester
- iv) Should not have failed in more than Four backlog subjects of 3rd Semester

5. A candidate shall be promoted to 6th semester provided he/she puts in the required percentage of attendance in the 5th semester and pays the examination fee.

A candidate who could not pay the 5th semester examination fee, has to pay the promotion fee as prescribed by State Board of Technical Education and Training from time to time before commencement of 6th semester.

A candidate is eligible to appear for 6th semester examination

- i) Puts the required percentage of attendance in 6th semester and
- ii) should get eligibility to appear for 4th Semester Examination.

For IVC & ITI Lateral Entry students:

- i) Puts the required percentage of attendance in 6th semester.
- ii) should get eligibility to appear for 5th Semester Examination.

6. A candidate shall be promoted to 7th semester provided he/she puts the required percentage of attendance in 6th semester and pay the examination fee. A candidate, who could not pay the 6th semester examination fee, has to pay the promotion fee prescribed by SBTET from time to time before commencement of the 7th semester (Industrial Training).

A candidate is eligible to appear for 7th semester Industrial Training assessment (Seminar/Viva-voce) if he/she

- i) Puts the required percentage of attendance, ie., 90% in 7th semester Industrial Training
- ii) Should get eligibility to appear for 4th Semester Examination.

For IVC & ITI Lateral Entry students:

- i) Puts the required percentage of attendance, ie., 90% in 7th semester Industrial Training.
- ii) Should get eligibility to appear for 5th Semester Examination.

Important Note:

Seminar/Viva-voce should not be conducted for Not-Eligible Candidates, till the candidate gets eligibility. However, the record of internal Assessment for Industrial Training for 260 marks shall be maintained at Institution Level for all candidates and the data is to be uploaded only for eligible candidates. For not eligible candidates the data is to be uploaded as and when the candidate gets eligibility.

OTHER DETAILS

- a) In case a candidate does not successfully complete the Industrial training, he / she will have to repeat the training at his / her own cost.
- b) The Industrial training shall commence 10 days after the completion of the last theory examination of 6th Semester.

13. STUDENTS PERFORMANCE EVALUATION

Successful candidates shall be awarded the Diploma under the following divisions of pass.

1. First Class with Distinction shall be awarded to the candidates who secure an overall aggregate of 75% marks and above.
2. First Class shall be awarded to candidates who secure overall aggregate of 60% marks and above and below 75% marks.
3. Second Class shall be awarded to candidates who secure a pass with an overall aggregate of below 60%.

The Weightage of marks for various year/Semesters which are taken for computing overall aggregate shall be 25% of I year marks + 100% of 3rd and subsequent Semesters.

In respect IVC & ITI Lateral Entry candidates who are admitted directly into diploma course at the 3rd semester (i.e., second year) level the aggregate of (100%) marks secured at the 3rd and subsequent semesters of study shall be taken into consideration for determining the overall percentage of marks secured by the candidates for award of class/division.

4. Second Class shall be awarded to all students, who fail to complete the Diploma in the regular 3 years/ 3 ½ years and four subsequent examinations, from the year of first admission.

14. EXAMINATION FEE SCHEDULE:

The examination fee should be as per the notification issued by State Board of Technical Education and Training from time to time.

15. STRUCTURE OF END EXAMINATION QUESTION PAPER:

The question paper for theory examination is patterned in such a manner that the Weightage of periods/marks allotted for each of the topics for a particular subject be considered Examination paper is of 3/6/9 hours duration.

- a) Each theory paper consists of Section 'A' and Section 'B'. Section 'A' contains 10 short answer questions. All questions are to be answered and each carries 3 marks
Max. Marks: $10 \times 3 = 30$.
Section B contains 8 essay type questions including Numerical questions, out of which 5 questions each carrying 10 marks are to be answered.

Max.Marks: $5 \times 10 = 50$.

Total Maximum Marks: 80.

- b) For Engineering Drawing Subject (107) consist of section 'A' and section 'B'. Section 'A' contains four (4) questions. All questions in section 'A' are to be answered and each carries 5 marks. Max. Marks: $4 \times 5=20$. Section 'B' contains six (6) questions. Out of which four (4) questions to be answered and each question carries 10 Marks. Max. Marks $4 \times 10 = 40$.

- c) Practical Examinations

For Workshop practice and Laboratory Examinations, Each student has to pick up a question paper distributed by Lottery System.

Max. Marks for an experiment / exercise : 50%

Max. Marks for VIVA-VOCE : 10%

Total : 60% (of total marks for the subject)

In case of practical examinations with 50 marks, the marks will be worked out basing on the above ratio.

In case of any change in the pattern of question paper, the same shall be informed sufficiently in advance to the candidates.

16. ISSUE OF MEMORANDUM OF MARKS

All candidates who appear for the end examination will be issued memorandum of marks without any payment of fee. However candidates who lose the original memorandum of marks have to pay the prescribed fee to the Secretary, State Board of Technical Education and Training, A.P. for each duplicate memo.

17. MAXIMUM PERIOD FOR COMPLETION OF DIPLOMA COURSES:

Maximum period for completion of the diploma courses is twice the duration of the course from the date of First admission (includes the period of detention and discontinuation of studies by student etc) failing which they will have to forfeit the claim for qualifying for the award of Diploma (They will not be permitted to appear for examinations after that date). This rule applies for all Diploma courses of 3 years and 3 ½ years of engineering and non-engineering courses.

18. ELIGIBILITY FOR AWARD OF DIPLOMA

A candidate is eligible for award of Diploma Certificate if he / she fulfils the following academic regulations.

- i. He / She pursued a course of study for not less than 3 / 3 ½ academic years & not more than 6 / 7 academic years.
- ii. He / she has completed all the subjects.

Students who fail to fulfill all the academic requirements for the award of the Diploma within 6 / 7 academic years from the year of admission shall forfeit their seat in the course & their seat shall stand cancelled.

For IVC & ITI Lateral Entry students:

- i. He / She pursued a course of study for not less than 2 / 2 ½ academic years & not more than 4 / 5 academic years.
- ii. He / she has completed all the subjects.

Students who fail to fulfill all the academic requirements for the award of the Diploma within 4 / 5 academic years from the year of admission shall forfeit their seat in the course & their seat shall stand cancelled.

19. ISSUE OF PHOTO COPY OF VALUED ANSWER SCRIPT, RECOUNTING & REVERIFICATION:

A) FOR ISSUE OF PHOTO COPIES OF VALUED ANSWER SCRIPTS

1. A candidate desirous of applying for Photo copy of valued answer script/ scripts should apply within prescribed date from the date of the declaration of the result.
2. Photo copies of valued answer scripts will be issued to all theory subjects and Drawing subject(s).
3. The Photo copy of valued answer script will be dispatched to the concerned candidate's address as mentioned in the application form by post.
4. No application can be entertained from third parties.

B) FOR RE-COUNTING(RC) and RE-VERIFICATION(RV) OF THE VALUED ANSWER SCRIPT

1. A candidate desirous of applying for Re-verification of valued answer script should apply within prescribed date from the date of the declaration of the result.
2. Re-verification of valued answer script shall be done for all theory subjects and Drawing subject(s).

3. The Re-verification committee constituted by the Secretary, SBTETAP with subject experts shall re-verify the answer scripts.

1) RE-COUNTING

The Officer of SBTET will verify the marks posted and recount them in the already valued answer script. The variations if any will be recorded separately, without making any changes on the already valued answer script. The marks awarded in the original answer script are maintained (hidden).

2) RE-VERIFICATION

- (i) The Committee has to verify the intactness and genuineness of the answer script(s) placed for Re-verification.
 - (ii) Initially single member shall carry out the re-verification.
 - (iii) On re-verification by single member, if the variation is less than 12% of maximum marks, and if there is no change in the STATUS in the result of the candidate, such cases will not be referred to the next level i.e., for 2-Tier evaluation.
 - (iv) On re-verification by a single member, if the variation is more than 12% of maximum marks, it will be referred to 2-Tier evaluation.
 - (v) If the 2-Tier evaluation confirms variation in marks as more than 12% of maximum marks, the variation is considered as follows:
 - a) If the candidate has already passed and obtains more than 12% of the maximum marks on Re-verification, then the variation is considered.
 - b) If the candidate is failed and obtains more than 12% of the maximum marks on Re-verification and secured pass marks on re-verification, then the status of the candidate changes to PASS.
 - c) If a candidate is failed and obtains more than 12% of the maximum marks on Re-verification and if the marks secured on re-verification are still less than the minimum pass marks, the status of the candidate remain FAIL only.
 - (vii) After Re-verification of valued answer script the same or change if any therein on Re-verification, will be communicated to the candidate.
 - (viii) On Re-verification of Valued Answer Script if the candidate's marks are revised, the fee paid by the candidate will be refunded or else the candidate has to forfeit the fee amount.
4. No request for Photo copies/ Recounting /Re-verification of valued answer script would be entertained from a candidate who is reported to have resorted to Malpractice in that examination.

20. MAL PRACTICE CASES:

If any candidate resorts to Mal Practice during examinations, he / she shall be booked and the Punishment shall be awarded as per SBTETAP rules and regulations in vogue.

21. DISCREPANCIES/ PLEAS:

Any Discrepancy /Pleas regarding results etc., shall be represented to the SBTETAP within one month from the date of issue of results. Thereafter, no such cases shall be entertained in any manner.

22. ISSUE OF DUPLICATE DIPLOMA

If a candidate loses his/her original Diploma Certificate and desires a duplicate to be issued he/she should produce written evidence to this effect. He / she may obtain a duplicate from the Secretary, State Board of Technical Education and Training, A.P., on payment of prescribed fee and on production of an affidavit signed before a First Class Magistrate (Judicial) and *non-traceable certificate* from the Department of Police. In case of damage of original Diploma Certificate, he / she may obtain a duplicate certificate by surrendering the original damaged certificate on payment of prescribed fee to the State Board of Technical Education and Training, A.P.

In case the candidate cannot collect the original Diploma within 1 year from the date of issue of the certificate, the candidate has to pay the penalty prescribed by the SBTET from time to time.

23. ISSUE OF MIGRATION CERTIFICATE AND TRANSCRIPTS:

The Board on payment of prescribed fee will issue these certificates for the candidates who intend to prosecute Higher Studies in India or Abroad.

24. GENERAL

- i. The Board may change or amend the academic rules and regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students, for whom it is intended, with effect from the dates notified by the competent authority.
- ii. All legal matters pertaining to the State Board of Technical Education and Training are within the jurisdiction of Vijayawada.
- iii. In case of any ambiguity in the interpretation of the above rules, the decision of the Secretary, SBTET, A.P is final.

DIPLOMA IN METALLURGICAL ENGINEERING

SCHEME OF INSTRUCTION AND EXAMINATION CURRICULUM - 2016 (FIRST YEAR)

Subject Code	Name of the Subject	Instruction Periods/ Week		Total Periods/ Year	Scheme of Examinations.			
		Theory	Practicals		Duration (hrs)	Sessional Marks	End Exam Marks	Total Marks
	Theory							
Met-101	English	03	--	90	03	20	80	100
Met-102	Engineering Mathematics-I	05	--	150	03	20	80	100
Met-103	Engineering Physics	04	--	120	03	20	80	100
Met-104	Engineering Chemistry & Environmental Studies	04	--	120	03	20	80	100
Met-105	Mineral Processing Technology	04	--	120	03	20	80	100
Met-106	Elements of Metallurgical Engineering	04		120	03	20	80	100
	Practicals							
Met-107	Engineering Drawing	--	06	180	03	40	60	100
Met-108	Workshop Practice	--	03	90	03	40	60	100
Met-109	Physics Laboratory	--	03+ 03	90+ 90	03	20	30	50
Met-110	Chemistry Laboratory	--			03	20	30	50
Met-111	Computer Fundamentals Laboratory	--	03	90	03	40	60	100
	Total	24	18	1260	--	280	720	1000

Met -101, 102,103,104,107,108,109,110 and 111 common with all other branches

DIPLOMA IN METALLURGICAL ENGINEERING
SCHEME OF INSTRUCTION AND EXAMINATION
(C-16 : III SEMESTER)

Subject Code	Name of the Subject	Instruction Periods/ Week		Total Periods/ Semester	Scheme of Examinations.			
		Theory	Practicals		Duration (hrs)	Sessional Marks	End Exam Marks	Total Marks
	Theory							
Met-301	Engineering Mathematics-II	05	-	75	03	20	80	100
Met-302	Electrical Technology	04	--	60	03	20	80	100
Met-303	Fuels, Refractories & Pyrometry	05	--	75	03	20	80	100
Met-304	Physical metallurgy	05	--	75	03	20	80	100
Met-305	Iron Making	05	--	75	03	20	80	100
	Practicals							
Met-306	Machine Drawing	--	06	90	03	40	60	100
Met-307	Fuels Lab	--	03	45	03	40	60	100
Met-308	Metallography Lab	--	06	90	03	40	60	100
Met -309	Mineral Dressing Lab		03	45	03	40	60	100
	Total	24	18	630	--	260	640	900

Note: Met-301 common to all branches

DIPLOMA IN METALLURGICAL ENGINEERING
SCHEME OF INSTRUCTION AND EXAMINATION
(C-16 : IV SEMESTER)

Subject Code	Name of the Subject	Instruction Periods/ Week		Total Periods/ Semester	Scheme of Examinations.			
		Theory	Practicals		Duration (hrs)	Sessional marks	End Exam marks	Total Marks
	Theory							
Met-401	Metallurgical Thermodynamics	05	--	75	03	20	80	100
Met-402	Materials Testing	04	--	60	03	20	80	100
Met-403	Foundry Technology	05	--	75	03	20	80	100
Met-404	Heat Treatment technology	05	--	75	03	20	80	100
Met-405	Steel Making	05	--	75	03	20	80	100
	Practicals							
Met-406	Material Testing Lab	--	06	90	03	40	60	100
Met-407	Heat Treatment lab	--	06	90	03	40	60	100
Met-408	Communication skills Lab Practice	--	03	45	03	40	60	100
Met -409	Foundry Lab		03	45	03	40	60	100
	Total	24	18	630	--	260	640	900

Note: Met-408 common to all branches

V SEMESTER
SCHEME OF INSTRUCTION AND EXAMINATION
(PRACTICAL TRAINING) Met-501

S No	Subject	Duration	Scheme of Examination			
			Nature	Item	Max. Marks	
1.	Practical training in a metallurgical Industry or allied Industry	6 Months	Viva Voce & Log book	<u>At the Industry</u>		
				1) First Assessment (During 3 rd month)		100
				2) Second Assessment (During 6 th month)		100
				<u>At the Institution</u>		
				4) Log Book		30
				5) Training Report		30
6) Seminar on training	40					
Total for V semester					300	

1. The Industrial training shall carry 300 marks and pass marks is 50%. A candidate failing to secure the minimum marks should complete it at his own expenses.

2. During Industrial training the candidate shall put a minimum of 90% attendance.

VI SEMESTER
SCHEME OF INSTRUCTION AND EXAMINATION
(PRACTICAL TRAINING) Met-601

S No	Subject	Duration	Scheme of Examination		
			Nature	Item	Max. Marks
1.	Practical training in a metallurgical Industry or allied Industry	6 Months	Viva Voce & Log book	<u>At the Industry</u>	
				1) First Assessment (During 2 nd month)	100
				2) Second Assessment (During 4 th month)	100
				<u>At the Institution</u>	
				4) Log Book	30
				5) Training Report	30
			6)Seminar on training	40	
Total for VI semester					300

1.The Industrial training shall carry 300 marks and pass marks is 50%. A candidate failing to secure the minimum marks should complete it at his own expenses.

2. During Industrial training the candidate shall put a minimum of 90% attendance.

DIPLOMA IN METALLURGICAL ENGINEERING
SCHEME OF INSTRUCTION AND EXAMINATION
(C-16 : VII SEMESTER)

Subject Code	Name of the Subject	Instruction Periods/ Week		Total Periods/ Semester	Scheme of Examinations.			
		Theory	Practicals		Duration (hrs)	Sessional marks	End Exam marks	Total Marks
Theory								
Met-701	Industrial Management and Smart Technologies	05	-	75	03	20	80	100
Met-702	Welding Technology	05	--	75	03	20	80	100
Met-703	Metal Casting Technology	05	--	75	03	20	80	100
Met-704	Mechanical Metallurgy	05	--	75	03	20	80	100
Met-705	Non ferrous Extractive Metallurgy	04	--	60	03	20	80	100
Practicals								
Met-706	Non- Destructive Testing Lab	--	03	45	03	40	60	100
Met-707	Life skills	--	03	45	03	40	60	100
Met-708	Metal Casting Practice & CAD Lab	--	06	90	03	40	60	100
Met -709	Project Work & Viva-voce		06	90	03	40	60	100
Total		24	18	630	--	260	640	900

Note: Met-701, 707 common to all branches

**I – YEAR
(C-16)**

C-16-COMMON-101- ENGLISH
(Common to all Branches)

Subject Title : ENGLISH
Subject Code : Common - 101
Periods per Week : 3
Periods per Year : 90

Time Schedule& Weightage

S. No	Major Topics	Titles of the Lessons	No. of Periods	Weightage of Marks	No of Short Answers	No of Long Answers
1	Vocabulary& Need for English	Lessons 1,2& Regular and essential vocabulary	5	13	1	1
2	Grammar	Lessons 11,12 & 19 to 26	30	31	7	1
3	Reading	Lessons 13 To 18	10	10	-	1
4	Writing	Lessons 27 To 40	30	40	-	4
5	English in Action	Lessons 3 To 10	15	16	2	1
		Total	90	110	10	08

Rationale and Scope

Globalization has ushered in an era of opportunities for those who have the necessary competencies. Effective communication is one among them. This shift demands strengthening of English in polytechnics. In C-16 Curriculum the focus is on the special needs of English for technicians.

. This course aims at integration of the four fold language abilities viz., listening, speaking, reading and writing. The use of English for learning technical subjects and for performing technical functions like, writing reports, giving instructions and interpreting graphics/data is of great importance. Therefore the curriculum C-16 focuses on improving communicative abilities equipping the students to become industry- ready and employable.

On completion of this course the student will be able to:

- 1.0 Build vocabulary in the direction of future needs
- 2.0 Learn various grammatical structures
- 3.0 Read and comprehend English and understand the details and draw inferences
- 4.0 Learn to be competent in various forms of written communication (writing composition and data interpretation)
- 5.0 Practice spoken communication suited to various situations.

1.0 Extend their vocabulary in the direction of their future needs

- 1.1 Locate words, learn spellings, understand meanings
- 1.2 Pronounce words intelligibly
- 1.3 Find synonyms and antonyms
- 1.4 Use affixation
- 1.5 Comprehend meanings of words by understanding meanings of roots

2.0 Learn various grammatical structures

- 2.1 Identify and use nouns
- 2.2 Identify and use pronouns
- 2.3 Use the present tense
- 2.4 Use the past tense
- 2.5 Use the future tense
- 2.6 Identify and use adjectives
- 2.7 Identify and use adverbs
- 2.8 Use prepositions
- 2.9 Use linkers
- 2.10 State basic sentence structures
- 2.11 Construct different types of sentences
- 2.12 Frame questions to elicit information
- 2.13 Frame questions for confirmation
- 2.14 Use active voice
- 2.15 Use passive voice
- 2.16 Use direct speech
- 2.17 Use indirect speech
- 2.18 Identify and correct errors

3.0 Read and comprehend English

- 3.1 Identify the main ideas
- 3.2 Identify the specific details
- 3.3 Draw inferences
- 3.4 Give contextual meanings of the words
- 3.5 Perceive tone in a text

- 4.0 Learn to excel in various forms of written communication (writing composition and data interpretation)**
- 4.1 Identify components of a good paragraph
- 4.2 Write types of paragraphs
- 4.3 Distinguish between formal and informal letters
- 4.4 Write personal letters
- 4.5 Write leave letters
- 4.6 Write official letters
- 4.7 Write letters of complaints
- 4.8 Prepare a resume
- 4.9 Write a cover letter
- 4.10 Write short messages
- 4.11 Report incidents
- 4.12 Report experiments
- 4.13 Report Industrial visits
- 4.14 Write work done statements
- 4.15 Write maintenance reports
- 4.16 Make notes using Cue method and Mapping method
- 4.17 Summarize Paragraphs
- 4.18 Present and Interpret Data from flow charts, tree diagrams, bar graphs, tables, pie charts

- 5.0 Practice spoken communication suited to various situations.**
- 5.1 Use appropriate expressions to greet and take leave
- 5.2 Use proper expressions to make requests
- 5.3 Use apt expressions for asking and giving directions
- 5.4 Use suitable expressions to seek and offer suggestions
- 5.5 Use suitable expressions to state intentions
- 5.6 Use suitable expressions to state feelings
- 5.7 Use appropriate expressions to state agreement and disagreement
- 5.8 Use proper expressions to make complaints
- 5.9 Use suitable expressions to express obligations

Course Material

The textbook prepared by the faculty of English of Polytechnics in AP.

Reference Books

1. Essential English Grammar (Intermediate Level) - Raymond Murphy
2. Learn English
(A Fun Book of Functional Language, Grammar and Vocabulary)- Santanu, Sinha, Chaudhuri
3. Grammar Builder (Entire Series) - Oxford University Press

4. High School English Grammar (Revised Edition)- Wren and Martin
5. Sentence skills with Readings (fourth Edition, Tata McGraw Hill)- John Langan, Paul Langan
6. Word Power Made Easy - Norman Lewis
7. Spoken English- Shashi Kumar and Dhamija

Unit III : Co-ordinate Geometry										
13	Straight Lines	5	3	6	1	1	0	0	0	0
14	Circle	4	2	5	0	0	0	0	1/2	0
15	Conic Sections	4	3	5	0	0	0	0	1/2	0
Unit – IV : Differential Calculus										
16	Limits and Continuity	4	2	3	0	1	0	0	0	0
17	Differentiation	18	10	23	1	0	0	1	1	0
S. No	Major Topic	No of Periods		Weightage of Marks	Short Type			Essay Type		
		Theory	Practice		R	U	App	R	U	App
Unit - V : Applications of Differentiation										
18	Geometrical Applications	3	2	5	0	0	0	0	0	1/2
19	Physical Applications	2	2	5	0	0	0	0	0	1/2
20	Maxima and Minima	3	4	5	0	0	0	0	0	1/2
21	Errors and Approximations	2	0	5	0	0	0	0	0	1/2
Total		92	58	110	6	4	0	2	2 1/2	3 1/2
				Marks	18	12	0	20	25	35

R: Remembering type 38 marks
U: Understanding type 37 marks
App: Application type 35 marks

Objectives

Upon completion of the course the student shall be able to:

UNIT – I

Algebra

1.0 Use Logarithms in engineering calculations

- 1.1 Define logarithm and list its properties.
- 1.2 Distinguish natural logarithms and common logarithms.
- 1.3 Explain the meaning of e and exponential function.
- 1.4 State logarithm as a function and its graphical representation.
- 1.5 Use the logarithms in engineering calculations.

2.0 Resolve Rational Fraction into sum of Partial Fractions in engineering problems

- 2.1 Define the following fractions of polynomials:
 1. Rational,
 2. Proper and
 3. Improper
- 2.2 Explain the procedure of resolving rational fractions of the type mentioned below into partial fractions

$$\begin{array}{ll} i) \frac{f(x)}{(x+a)(x+b)(x+c)} & ii) \frac{f(x)}{(x+a)^2(x+b)(x+c)} \\ iii) \frac{f(x)}{(x^2+a)(x+b)} & iv) \frac{f(x)}{(x+a)(x^2+b)^2} \end{array}$$

3.0 Use Matrices for solving engineering problems

- 3.1 Define a matrix and order of a matrix.
- 3.2 State various types of matrices with examples (upto 3rd order square matrices).
- 3.3 Compute sum, scalar multiplication and product of matrices.
- 3.4 Illustrate the properties of these operations such as associative, distributive, commutative properties with examples and counter examples.
- 3.5 Define the transpose of a matrix and write its properties.
- 3.6 Define symmetric and skew-symmetric matrices.

- 3.7 Resolve a square matrix into a sum of symmetric and skew- symmetric matrices with examples in all cases.
- 3.8 Define minor, co-factor of an element of 2x2 and 3x3 square matrices with examples.
- 3.9 Expand the determinant of a 3 x 3 matrix using Laplace expansion formula.
- 3.10 Distinguish singular and non-singular matrices.
- 3.11 State properties of determinants with simple examples.
- 3.12 Define multiplicative inverse of a matrix and list properties of adjoint and inverse.
- 3.13 Compute adjoint and multiplicative inverse of a square matrix.
- 3.14 Representation of system of linear equations (2 variables in 2 equations and 3 variables in 3 equations) in matrix form.
- 3.15 Solve system of linear equations using Cramer's rule.
- 3.16 Solve system of linear equations by matrix inversion method
- 3.17 State elementary row operations.
- 3.18 Solve a system of linear equations by Gauss- Jordan method

UNIT – II

Trigonometry :

- 4.0 Understand Trigonometric Ratios
- 4.1 Define trigonometric ratios of any angle.
- 4.2 List the values of trigonometric ratios at specified values.
- 4.3 Draw graphs of trigonometric functions
- 4.4 Explain periodicity of trigonometric functions.
- 5.0 Solve simple problems on Compound Angles**
- 5.1 Define compound angles and state the formulae of $\sin(A\pm B)$, $\cos(A\pm B)$, $\tan(A\pm B)$ and $\cot(A\pm B)$
- 5.2 Give simple examples on compound angles to derive the values of $\sin 15^\circ$, $\cos 15^\circ$, $\sin 75^\circ$, $\cos 75^\circ$, $\tan 15^\circ$, $\tan 75^\circ$ etc.
- 5.3 Derive identities like $\sin(A+B)\sin(A-B) = \sin^2 A - \sin^2 B$ etc.,
- 5.4 Solve simple problems on compound angles.
- 6.0 Solve problems using the formulae for Multiple and Sub- multiple Angles**
- 6.1 Derive the formulae of multiple angles $2A$, $3A$ etc and sub multiple angles $A/2$ in terms of angle A of trigonometric functions.
- 6.2 Derive useful allied formulas like $\sin A = (1 - \cos 2A)/2$ etc.,

6.3 Solve simple problems using the above formulae

7.0 Apply Transformations for solving the problems in Trigonometry

7.1 Derive the formulae on transforming sum or difference of two trigonometric ratios into a product and vice versa- examples on these formulae.

8.0 Use Inverse Trigonometric Functions for solving engineering problems

8.1 Explain the concept of the inverse of a trigonometric function by selecting an appropriate domain and range.

8.2 Define inverses of six trigonometric functions along with their domains and ranges.

8.3 Derive relations between inverse trigonometric functions so that given $A = \sin^{-1}x$, express angle A in terms of other inverse trigonometric functions - with examples.

8.4 State various properties of inverse trigonometric functions and identities like $\sin^{-1}x + \cos^{-1}x = \frac{\pi}{2}$ etc.

8.5 Derive formulae like $\tan^{-1}x + \tan^{-1}y = \tan^{-1}\left(\frac{x+y}{1-xy}\right)$, where $x \geq 0, y \geq 0, xy < 1$ etc., and solve simple problems.

9.0 Solve Trigonometric Equations in engineering applications

9.1 Explain what is meant by solutions of trigonometric equations and find the general solutions of $\sin x = k$, $\cos x = k$ and $\tan x = k$ with appropriate examples.

9.2 Solve models of the type $a \sin^2 x + b \sin x + c = 0$, $a \cos x + b \sin x = c$ etc., and problems using simple transformations.

10.0 Appreciate Properties of triangles and their solutions

10.1 State sine rule, cosine rule, tangent rule and projection rule.

10.2 Explain the formulae for $\sin A/2$, $\cos A/2$, $\tan A/2$ and $\cot A/2$ in terms of semi-perimeter and sides a, b, c .

10.3 List various formulae for the area of a triangle.

10.4 Solve problems using the above formulae.

10.5 Solve a triangle when (i) three sides, (ii) two sides and an included angle, (iii) two sides and an opposite angle-case of two solutions and (iv) one side and two angles are given.

11.0 Represent the Hyperbolic Functions in terms of logarithm functions

11.1 Define Sinh x, cosh x and tanh x and list the hyperbolic identities.

11.2 Represent inverse hyperbolic functions in terms of logarithms.

12.0 Represent Complex numbers in various forms

12.1 Define complex number, its modulus, conjugate and list their properties.

12.2 Define the operations on complex numbers with examples.

- 12.3 Define amplitude of a complex number
- 12.4 Represent the complex number in various forms like modulus-amplitude (polar) form, Exponential (Euler) form – illustrate with examples.
- 12.5 State DeMoivre's theorem and its applications to complex numbers e.g., finding the roots, powers, simplifications of a complex number with illustrative examples

UNIT - III

Coordinate Geometry

13.0 Solve the problems on Straight lines

- 13.1 Write the different forms of a straight line – point slope form, two point form, intercept form, normal form and general form
- 13.2 Solve simple problems on the above forms
- 13.3 Find distance of a point from a line, acute angle between two lines, intersection of two non-parallel lines and distance between two parallel lines.

14.0 Solve the problems on Circles

- 14.1 Define locus of a point – circle and its equation.
- 14.2 Find the equation of a circle given
 - (i) Center and radius
 - (ii) Two ends of a diameter
 - (iii) Centre and a point on the circumference
 - (iv) Three non collinear points
- 14.3 Write the general equation of a circle and find the centre and radius.

15.0 Appreciate the properties of Conics in engineering applications

- 15.1 Define a conic section.
- 15.2 Explain the terms focus, directrix, eccentricity, axes and latus rectum of a conic with illustrations.
- 15.3 Find the equation of a conic when focus, directrix and eccentricity are given
- 15.4 Describe the properties of Parabola, Ellipse and Hyperbola in standard form.

UNIT - IV

Differential Calculus

16.0 Use the concepts of Limit and Continuity for solving the problems

16.1 Explain the concept of limit and meaning of $\lim_{x \rightarrow a} f(x) = l$ and state the properties of limits.

16.2 Mention the Standard limits $\lim_{x \rightarrow a} \frac{x^n - a^n}{x - a}$, $\lim_{x \rightarrow 0} \frac{\sin x}{x}$, $\lim_{x \rightarrow 0} \frac{\tan x}{x}$, $\lim_{x \rightarrow 0} \frac{a^x - 1}{x}$,

$$\lim_{x \rightarrow 0} \frac{e^x - 1}{x}, \quad \lim_{x \rightarrow 0} (1 + x)^{\frac{1}{x}}, \quad \lim_{x \rightarrow \infty} \left(1 + \frac{1}{x}\right)^x \quad (\text{All without proof}).$$

16.3 Solve the problems using the above standard limits

16.4 Evaluate the limits of the type $\lim_{x \rightarrow l} \frac{a x^2 + b x + c}{\alpha x^2 + \beta x + \gamma}$ and $\lim_{x \rightarrow \infty} \frac{f(x)}{g(x)}$

16.5 Explain the concept of continuity of a function at a point and on an interval with some examples whether a given function is continuous or not.

17.0 Appreciate Differentiation and its meaning in engineering situations

17.1 State the concept of derivative of a function $y = f(x)$ – definition, first principle as

$\lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$ and also provide standard notations to denote the derivative of a function.

17.2 State the significance of derivative in scientific and engineering applications.

17.3 Find the derivatives of elementary functions like x^n , a^x , e^x , $\log x$, $\sin x$, $\cos x$, $\tan x$, $\text{Sec} x$, $\text{Cosec} x$ and $\text{Cot} x$ using the first principles.

17.4 Find the derivatives of simple functions from the first principle.

17.5 State the rules of differentiation of sum, difference, scalar multiplication, product and quotient of functions with illustrative and simple examples.

17.6 Explain the method of differentiation of a function of a function (Chain rule) with illustrative examples such as

$$\text{(i)} \sqrt{t^2 + \frac{2}{t}} \quad \text{(ii)} x^2 \sin 2x \quad \text{(iii)} \frac{x}{\sqrt{x^2 + 1}} \quad \text{(iv)} \log(\sin(\cos x)).$$

17.7 Find the derivatives of Inverse Trigonometric functions and examples using the Trigonometric transformations.

17.8 Explain the method of differentiation of a function with respect to another function and also differentiation of parametric functions with examples.

17.9 Find the derivatives of hyperbolic functions.

- 17.10 Explain the procedures for finding the derivatives of implicit function with examples.
- 17.11 Explain the need of taking logarithms for differentiating some functions with examples like $[f(x)]^{g(x)}$.
- 17.12 Explain the concept of finding the higher order derivatives of second and third order with examples.
- 17.13 Explain the concept of functions of several variables, partial derivatives and difference between the ordinary and partial derivatives with simple examples.
- 17.14 Explain the definition of Homogenous function of degree n
- 17.15 Explain Euler's theorem for homogeneous functions with applications to simple problems.

UNIT - V

Applications of the Differentiation

18.0 Understand the Geometrical Applications of Derivatives

- 18.1 State the geometrical meaning of the derivative as the slope of the tangent to the curve $y=f(x)$ at any point on the curve.
- 18.2 Explain the concept of derivative to find the slope of tangent and to find the equation of tangent and normal to the curve $y=f(x)$ at any point on it.
- 18.3 Find the lengths of tangent, normal, sub-tangent and sub normal at any point on the curve $y=f(x)$.
- 18.4 Explain the concept of angle between two curves and procedure for finding the angle between two given curves with illustrative examples.

19.0 Understand the Physical Applications of Derivatives

- 19.1 Explain the derivative as a rate of change in distance-time relations to find the velocity and acceleration of a moving particle with examples.
- 19.2 Explain the derivative as a rate measurer in the problems where the quantities like volumes, areas vary with respect to time- illustrative examples.

20.0 Use Derivatives to find extreme values of functions

- 20.1 Define the concept of increasing and decreasing functions.
- 20.2 Explain the conditions to find points where the given function is increasing or decreasing with illustrative examples.
- 20.3 Explain the procedure to find the extreme values (maxima or minima) of a function of single variable - simple problems yielding maxima and minima.
- 20.4 Solve problems on maxima and minima in applications like finding areas, volumes, etc.

21.0 Use Derivatives to find Errors and Approximations

- 21.1 Find the absolute error, approximate error, relative error and percentage error in functions of single variable.

COURSE CONTENT

Unit-I

Algebra

1. Logarithms :

Definition of logarithm and its properties, natural and common logarithms; the meaning of e and exponential function, logarithm as a function and its graphical representation.

2. Partial Fractions :

Rational, proper and improper fractions of polynomials. Resolving rational fractions into their partial fractions covering the types mentioned below:

$$\begin{array}{ll} i) \quad \frac{f(x)}{(x+a)(x+b)(x+c)} & ii) \quad \frac{f(x)}{(x+a)^2(x+b)(x+c)} \\ iii) \quad \frac{f(x)}{(x^2+a)(x+b)} & iv) \quad \frac{f(x)}{(x+a)(x^2+b)^2} \end{array}$$

Matrices:

3. Definition of matrix, types of matrices-examples, algebra of matrices-equality of two matrices, sum, scalar multiplication and product of matrices. Transpose of a matrix-Symmetric, skew symmetric matrices-Minor, cofactor of an element-Determinant of a square matrix-Laplace's expansion, properties of determinants. Singular and non singular matrices-Adjoint and multiplicative inverse of a square matrix- examples-System of linear equations in 2 or 3 variables-Solutions by Cramer's rule, Matrix inversion method-examples-Elementary row operations on matrices -Gauss-Jordan method to solve a system of equations.

Unit-II

Trigonometry :

4. Trigonometric ratios: definition of trigonometric ratios of any angle, values of trigonometric ratios at specified values, draw graphs of trigonometric functions, periodicity of trigonometric functions.
5. Compound angles: Formulas of $\sin(A\pm B)$, $\cos(A\pm B)$, $\tan(A\pm B)$, $\cot(A\pm B)$, and related identities with problems.
6. Multiple and sub multiple angles: trigonometric ratios of multiple angles $2A, 3A$ and submultiple angle $A/2$ with problems.
7. Transformations of products into sums or differences and vice versa simple problems
8. Inverse trigonometric functions : definition, domains and ranges-basic properties- problems.
9. Trigonometric equations: concept of a solution, principal value and general solution of trigonometric equations :
 $\sin x = k$, $\cos x = k$, $\tan x = k$.
 Solutions of simple quadratic equations, equations involving usage of transformations- problems.
10. Properties and solutions of triangles: relation between sides and angles of a triangle- sine rule, cosine rule, tangent rule and projection rule-area of a triangle- solving a triangle- problems.
11. Hyperbolic functions: Definitions of hyperbolic functions, identities of hyperbolic functions, inverse hyperbolic functions and expression of inverse hyperbolic functions in terms of logarithms.
12. Complex Numbers: Definition of a complex number, Modulus and conjugate of a complex number, Arithmetic operations on complex numbers, Modulus- Amplitude (polar) form, Exponential form (Euler) form of a complex number- Problems. DeMoivre's Theorem and its applications in complex numbers- Simple problems.

UNIT-III

Coordinate geometry

13. Straight lines: various forms of straight lines, angle between lines, perpendicular distance from a point, distance between parallel lines-examples.
14. Circle: locus of a point, Circle definition-Circle equation given (i) center and radius, (ii) two ends of a diameter (iii) centre and a point on the circumference (iv) three non collinear points - general equation of a circle - finding center, radius.
15. Definition of a conic section, equation of a conic when focus directrix and eccentricity are given. Properties of parabola, ellipse and hyperbola, standard forms.

UNIT-IV

Differential Calculus

16. Concept of Limit- Definition- Properties of Limits and Standard Limits -Simple Problems-Continuity of a function at a point- Simple Examples only.
17. Concept of derivative- definition (first principle) - different notations-derivatives of elementary functions - problems. Derivatives of sum, product, quotient, scalar multiplication of functions - problems. Chain rule, derivatives of inverse trigonometric functions, derivative of a function with respect to another function, derivative of parametric functions, derivative of hyperbolic, implicit functions, logarithmic differentiation – problems in each case. Higher order derivatives - examples – functions of several variables – partial differentiation, Euler’s theorem-simple problems.

UNIT-V

Applications of Derivatives:

18. Geometrical meaning of the derivative, equations of Tangent and normal to a curve at any point. Lengths of tangent, normal, sub tangent and subnormal to the curve at any point. Angle between the curves - problems.
19. Physical applications of the derivative – velocity, acceleration, derivative as a rate Measure – Problems.
20. Applications of the derivative to find the extreme values – Increasing and decreasing functions, finding the maxima and minima of simple functions - problems leading to applications of maxima and minima.
21. Applications of derivative in finding errors and approximations of functions and simple problems.

Reference Books :

1. A text book of matrices by Shanti Narayan,
2. Plane Trigonometry, by S.L Loney
3. Co-ordinate Geometry, by S.L Loney
4. Thomas Calculus, Pearson Addison-Wesley publishers
5. Calculus – I, by Shanti Narayan and Manicavachgam Pillai, S.V Publications

ENGINEERING PHYSICS

Subject Title	:	Engineering Physics
Subject Code	:	Common -103
Periods per week	:	04
Total periods per year	:	120

TIME SCHEDULE

S.No	Major Topics	No. of Periods	Weightage of Marks	Short Answer Type	Essay Type
1.	Units and Dimensions	08	03	1	-
2.	Elements of Vectors	12	13	1	1
3.	Kinematics	14	13	1	1
4.	Friction	08	10	-	1
5.	Work, Power and Energy	12	10	-	1
6.	Simple Harmonic Motion	12	13	1	1
7.	Heat & Thermodynamics	12	13	1	1
8.	Sound	12	13	1	1
9.	Properties of matter	10	06	2	-
10.	Electricity & magnetism	12	13	1	1
11.	Modern Physics	08	03	1	-
	Total:	120	110	10	8

OBJECTIVES

Upon completion of the course the student shall be able to

1.0 Understand the concept of Units and dimensions

- 1.1 Explain the concept of Units
- 1.2 Define the terms
 - a) Physical quantity, b) Fundamental physical quantities and
 - c) Derived physical quantities
- 1.3 Define unit
- 1.4 Define fundamental units and derived units
- 1.5 State SI units with symbols
- 1.6 State Multiples and submultiples in SI system
- 1.7 State Rules of writing S.I. units
- 1.8 State advantages of SI units
- 1.9 Define Dimensions
- 1.10 Write Dimensional formulae
- 1.11 Derive dimensional formulae of physical quantities
- 1.12 List dimensional constants and dimensionless quantities
- 1.13 State the principle of Homogeneity of Dimensions
- 1.14 State the applications of Dimensional analysis
- 1.15 State the limitations of dimensional analysis
- 1.16 Solve problems

2.0 Understand the concept of Elements of Vectors

- 2.1 Explain the concept of Vectors
- 2.2 Define Scalar and Vector quantities

- 2.3 Give examples for scalar and vector quantities
- 2.4 Represent vectors graphically
- 2.5 Classify the Vectors
- 2.6 Resolve the vectors
- 2.7 Determine the Resultant of a vector by component method
- 2.8 Represent a vector in space using unit vectors (i, j, k)
- 2.9 State triangle law of addition of vectors
- 2.10 State parallelogram law of addition of vectors
- 2.11 Illustrate parallelogram law of vectors in case of flying bird and sling.
- 2.12 Derive expression for magnitude and direction of resultant of two vectors
- 2.13 State polygon law of addition of vectors
- 2.14 Explain subtraction of vectors
- 2.15 Define Dot product of two vectors with examples (Workdone, Power)
- 2.16 Mention the properties of Dot product
- 2.17 Define Cross products of two vectors with examples (Torque, Linear velocity)
- 2.18 Mention the properties of Cross product.
- 2.19 Solve the related numerical problems

3.0 Understand the concept of Kinematics

- 3.1 Write the equations of motion in a straight line
- 3.2 Explain the acceleration due to gravity
- 3.3 Derive expressions for vertical motion
 - a) Maximum Height, b) time of ascent, c) time of descent, and d) time of flight
- 3.4 Derive height of a tower when a body projected vertically upwards from the top of a tower.
- 3.5 Explain projectile motion with examples
- 3.6 Explain Horizontal projection
- 3.7 Derive an expression for the path of a projectile in horizontal projection
- 3.8 Explain oblique projection
- 3.9 Derive an expression for the path of projectile in oblique projection
- 3.10 Derive formulae for projectile in oblique projection
 - a) Maximum Height, b) time of ascent, c) time of descent, and d) time of flight
 - e) Horizontal Range, f) Maximum range
- 3.11 Solve the related numerical problems

4.0 Understand the concept of Friction

- 4.1 Define friction
- 4.2 Classify the types of friction and define
- 4.3 Explain the concept of Normal reaction
- 4.4 State the laws of friction
- 4.5 Define coefficients of friction
- 4.6 Explain the Angle of friction
- 4.7 Derive an expression for acceleration of a body on a rough horizontal surface
- 4.8 Derive an expression for the displacement and time taken to come to rest over a rough horizontal surface
- 4.9 Define Angle of repose
- 4.10 Derive expressions for acceleration of a body on a smooth inclined plane (up

and down)

4.11 Derive expressions for acceleration of a body on a rough inclined plane (up and down)

4.12 List the Advantages and Disadvantages of friction

4.13 Mention the methods of minimizing friction

4.14 Solve the related numerical problems

5.0 Understand the concepts of Work, Power, and Energy

5.1 Define the terms 1. Work, 2. Power and Energy

5.2 State SI units and dimensional formulae for 1. Work, 2. Power, and Energy

5.3 Define potential energy and state examples

5.4 Derive the expression for Potential energy

5.5 Define kinetic energy and state examples

5.6 Derive the expression for kinetic energy

5.7 State and derive Work- Energy theorem

5.8 Derive the relation between Kinetic energy and momentum

5.9 State the law of conservation of energy and mention examples

5.10 Verify the law of conservation of energy in the cases of a freely falling body and vertically projected body in the upward direction

5.11 Solve the related numerical problems

6.0 Understand the concept of Simple harmonic motion

6.1 Define Simple harmonic motion

6.2 Give examples for Simple harmonic motion

6.3 State the conditions of Simple harmonic motion

6.4 Explanation of SHM in terms of projection of circular motion on any one of the diameters of the circular path

6.5 Derive expression for displacement

6.6 Derive expression for velocity

6.7 Derive expression for acceleration

6.8 Derive expression for Time period and frequency of S H M

6.9 Define phase of S H M and explain from the expression of displacement

6.10 Define Ideal simple pendulum and derive expression for Time period of simple pendulum

6.11 State the laws of motion of simple pendulum and mention formulae

6.12 Solve the related numerical problems

7.0 Understand the concept of Heat and thermodynamics

7.1 Explain the concept of expansion of gases

7.2 State and explain Boyle's law and also express it in terms of density

7.3 Define absolute zero temperature

7.4 Explain absolute scale of temperature

7.5 State Charles laws in terms of absolute temperature and explain

7.6 Define ideal gas and distinguish from real gas

7.7 Derive Ideal gas equation

7.8 Define Specific gas constant and Universal gas constant

7.9 Explain why universal gas constant is same for all gases

7.10 State SI unit and dimensional formula of universal gas constant

7.11 Calculate the value of universal gas constant

- 7.12 State the gas equation in different forms (as a function of density and mass)
- 7.13 Distinguish between r and R
- 7.14 State and Explain Isothermal process
- 7.15 State and Explain adiabatic process
- 7.16 Distinguish between isothermal and adiabatic processes
- 7.17 State first and second laws of thermodynamics and state applications
- 7.18 Define specific heats & molar specific heats of a gas and differentiate them
- 7.19 Derive the relation $C_p - C_v = R$ (Mayer's Equation)
- 7.20 Solve the relevant numerical problems

8.0 Understand the concept of Sound

- 8.1 Define the term sound
- 8.2 Explain longitudinal and transverse wave motion and state differences
- 8.3 Distinguish between musical sound and noise
- 8.4 Explain noise pollution and state SI unit for intensity level of sound
- 8.5 Explain causes of noise pollution
- 8.6 Explain effects of noise pollution
- 8.7 Explain methods of minimizing noise pollution
- 8.8 Explain the phenomenon of beats
- 8.9 State the applications of beats
- 8.10 Define Doppler effect
- 8.11 List the Applications of Doppler effect
- 8.12 Define reverberation and reverberation time
- 8.13 Write Sabine's formula and name the parameters contained
- 8.14 Define and Explain echoes and also state its applications
- 8.15 State conditions of good auditorium
- 8.16 Solve the related numerical problems

9.0 Understand the properties of matter

- 9.1 Define the term Elasticity
- 9.2 Define the terms stress and strain and also define different types of stress and strain
- 9.3 State the units and dimensional formulae for stress and strain
- 9.4 State and explain Hooke's law
- 9.5 Define surface tension and state examples
- 9.6 Explain Surface tension with reference to molecular theory
- 9.7 Define angle of contact
- 9.8 Define capillarity
- 9.9 Write the formula for surface tension based on capillarity and name the parameters
- 9.10 Explain the concept of Viscosity
- 9.11 Mention examples of Viscosity
- 9.12 State Newton's formula for viscous force and explain
- 9.13 Define co-efficient of viscosity and write its units and dimensional formula
- 9.14 Explain the effect of temperature on viscosity of liquids and gases
- 9.15 State Poiseuille's equation for Co-efficient of viscosity and name the physical quantities involved
- 9.16 Solve the related numerical problems

10.0 Understand the concept of Electricity and Magnetism

- 10.1 Explain the concept of Electricity
- 10.2 State Ohm's law and write the formula
- 10.3 Explain Ohm's law
- 10.4 Define specific resistance, conductance and state their units
- 10.5 State Kichoff's laws
- 10.6 Explain Kichoff's laws
- 10.7 Describe Wheatstone's bridge with legible sketch
- 10.8 Derive an expression for balancing condition of Wheatstone's bridge
- 10.9 Describe Meter Bridge experiment for the determination of resistivity with a neat circuit diagram
- 10.10 Write the formula in Meter Bridge to determine specific resistance
- 10.11 Explain the concept of magnetism
- 10.12 State the Coulomb's inverse square law of magnetism
- 10.13 Define magnetic field and magnetic lines of force and write the properties of magnetic lines of force
- 10.14 State the Magnetic induction field strength and mention its units and dimensional formula
- 10.15 Derive an expression for the moment of couple on a bar magnet placed in a uniform magnetic field
- 10.16 Derive Magnetic induction field strength at a point on the axial line
- 10.17 Derive Magnetic induction field strength at a point on the equatorial line
- 10.18 Solve the related numerical problems

11.0 Understand the concept of Modern physics

- 11.1 State and Explain Photo-electric effect
- 11.2 Write Einstein's photoelectric equation and explain
- 11.3 State laws of photoelectric effect
- 11.4 Explain the Working of photoelectric cell
- 11.5 List the Applications of photoelectric effect
- 11.6 Recapitulate refraction of light and its laws
- 11.7 Define critical angle
- 11.8 Explain the Total Internal Reflection
- 11.9 Explain the principle and working of Optical Fiber
- 11.10 Mention types of optical fibbers
- 11.11 List the applications of Optical Fiber
- 11.12 Define super conductor and superconductivity and mention examples for superconductors
- 11.13 State the properties of superconducting materials
- 11.14 List the applications of superconductors

COURSE CONTENT

1. Units and Dimensions:

Introduction – Physical quantity – Fundamental and Derived quantities – Fundamental and Derived units- SI units –Multiples and Sub multiples – Rules for writing S.I. units-Advantages of SI units – Dimensions and Dimensional formulae- Dimensional constants and

Dimensionless quantities- Principle of Homogeneity- Advantages and limitations of Dimensional analysis- - Problems.

2. Elements of Vectors:

Scalars and Vectors –Types of vectors(Proper Vector, Null Vector, Unit Vector, Equal , Negative Vector, Like Vectors, Co-Initial Vectors, Co-planar Vectors and Position Vector).Addition of vectors- Representation of vectors- Resolution of vectors - Parallelogram, Triangle and Polygon laws of vectors–Subtraction of vectors- Dot and Cross products of vectors-Problems

3. Kinematics

Introduction- Concept of acceleration due to gravity- Equations of motion for a freely falling body and for a body thrown up vertically- Projectiles- Horizontal and Oblique projections- Expressions for maximum height, time of flight, range - problems

4. Friction:

Introduction to friction- Causes- Types of friction- Laws of friction- Angle of repose-Angle of friction— Motion of a body over a horizontal surface- smooth inclined plane- rough inclined plane- Advantages and disadvantages of friction- Methods of reducing friction – Problems

5. Work, Power and Energy:

Work, Power and Energy- Definitions and explanation- potential energy- kinetic energy- Derivations of Potential and Kinetic energies-K.E and Momentum relation - Work-Energy theorem- Law of Conservation of energy- Problems

6. Simple Harmonic Motion:

Introduction- Conditions of SHM- Definition- Examples- Expressions for displacement, velocity, acceleration, Time period, frequency and phase in SHM- Time period of a simple pendulum- Laws of simple pendulum-seconds pendulum- Problems

7. Heat and Thermodynamics:

Expansion of Gases- Boyle's law- Absolute scale of temperature- Charles laws- Ideal gas equation- Universal gas constant- Differences between r and R - Isothermal and adiabatic processes- Laws of thermodynamics- Specific heats - molar specific heats of a gas –Derivation of Mayer's Equation- Problems

8. Sound:

Sound- Nature of sound- Types of wave motion -musical sound and noise- Noise pollution – Causes & effects- Methods of reducing noise pollution- Beats- Doppler effect- Echo- Reverberation-Reverberation time-Sabine 's formula-Conditions of good auditorium- Problems

9. Properties of matter

Definition of Elasticity –Definition of stress and strain -the units and dimensional formulae for stress and strain-The Hooke's law- Definition of surface tension- Explanation of Surface tension with reference to molecular theory - Definition of angle of contact - Definition of capillarity -The formula for surface tension based on capillarity - Explanation of concept of Viscosity - Examples for surface tension and Viscosity - Newton's formula for viscous force- Definition of co-efficient of viscosity- The effect of temperature on viscosity of liquids and gases - Poiseuille's equation for Co-efficient of viscosity- The related numerical problems

10. Electricity & Magnetism:

Ohm's law and explanation- Specific resistance- Kirchoff 's laws- Wheatstone's bridge - Meter bridge- Coulomb's inverse square law magnetic field- magnetic lines of

force-Magnetic induction field strength- magnetic induction field strength at a point on the axial line - magnetic induction field strength at a point on the equatorial line –problems.

11. Modern Physics;

Photoelectric effect –Einstein’s photoelectric equation-laws of photoelectric effect - photoelectric cell –Applications of photo electric effect- Total internal reflection- fiber optics- - principle and working of an optical fiber-types of optical fibers - Applications of optical fibers- superconductivity - applications

REFERENCE BOOKS

- | | |
|---|------------------------------------|
| 1. Intermediate physics Volume-I & 2 | Telugu Academy (English version) |
| 2. Unified physics Volume 1,2,3 and 4 | Dr.S.L Guptha and Sanjeev Guptha |
| 3. Text book of physics Volume I | Resnick & Holiday |
| 4. Text book of applied physics | Dhanpath Roy |
| 5. Fibre optics | D.A Hill |
| 6. NCERT Text Books ----- XI & XII Standard | |

Blue Print for setting question paper at different levels

S.No	Major Topics	No. of Periods	Weightage of Marks	Short answer type			Essay type		
				K	U	A	K	U	A
1.	Units and Dimensions	08	03	1	0	0	0	0	0
2.	Elements of Vectors	12	13	0	0	1	0	1	0
3.	Kinematics	14	13	0	1	0	1	0	0
4.	Friction	08	10	0	0	0	0	1	0
5.	Work, Power and Energy	12	10	0	0	0	0	1	0
6.	Simple Harmonic Motion	12	13	0	0	1	0	1	0
7.	Heat & Thermodynamics	12	13	0	1	0	1	0	0
8.	Sound	12	13	0	1	0	0	0	1
9.	Properties of Matter	10	06	1	1	0	0	0	0
10.	Electricity & magnetism	12	13	0	1	0	0	1	0
11.	Modern Physics	08	03	1	0	0	0	0	0
	Total:	120	110	3	5	2	2	5	1

ENGINEERING CHEMISTRY & ENVIRONMENTAL STUDIES
(Common to all Branches)

Subject Title : **Engineering Chemistry & Environmental Studies**
Subject Code : **Common-104**
Periods per week : **04**
Total periods per year : **120**

Scheme of instruction and examination Time Schedule

S.No	Major topic	No of Periods	Weight age of marks	Short type (3marks)			Essay type (10 marks)			remarks
				R	U	A	R	U	A	
A. ENGINEERING CHEMISTRY										
1	Fundamentals of Chemistry	18	16	1	0	1	0	1	0	
2	Solutions	10	8	1	0	0	0	0	1/2	5 mark
3	Acids and bases	10	8	0	0	1	0	1/2	0	5 mark
4	Principles of Metallurgy	10	10	0	0	0	1	0	0	
5	Electrochemistry	14	13	0	1	0	0	0	1	
6	Corrosion	8	10	0	0	0	0	1	0	
7	Water Technology	14	13	1	0	0	1	0	0	
8	Polymers	12	13	1	0	0	1	0	0	
9	Fuels	6	3	1	0	0	0	0	0	
B. ENVIRONMENTAL STUDIES		18	16	1	1	0	0	1	0	
total		120	110	6	2	2	3	3	1	
				18	6	6	30	35	15	

OBJECTIVES

Upon completion of the course the student shall be able to

A. ENGINEERING CHEMISTRY

1.0 Understand the concept of Atomic structure

- 1.1 Explain the charge and mass of fundamental particles of an atom (electron, proton and neutron)
- 1.2 Explain the concept of atomic number and mass number.
- 1.3 State the Postulates of Bohr's atomic theory and its limitations.
- 1.4 Explain the significance of four Quantum numbers.

- 1.5 Explain 1. Aufbau principle, 2 Pauli's exclusion principle 3 Hund's rule.
- 1.6 Define Orbital in an atom.
- 1.7 Draw the shapes of s, p and d - Orbitals .
- 1.8 Distinguish between Orbit and Orbital
- 1.9 Write the electronic configuration of elements up to atomic number 30
- 1.10 Explain the significance of chemical bonding
- 1.11 Explain the Postulates of Electronic theory of valency
- 1.12 Define the types of Chemical bonding viz., Ionic, Covalent bonds.
- 1.13 Explain the types of Chemical bonding viz., Ionic, Covalent bonds with examples.
- 1.14 Explain bond formation in NaCl and MgO.
- 1.15 List Properties of Ionic compounds
- 1.16 Explain bond formation in Hydrogen molecule, Oxygen molecule, and Nitrogen molecule using Lewis dot method.
- 1.17 List Properties of Covalent compounds
- 1.18 Distinguish between properties of ionic compounds and covalent compounds.
- 1.19 Structures of ionic solids-define a) Unit cell b) co-ordination number.
- 1.20 Structures of Unit cells of NaCl and CsCl.
- 1.21 Define the term. Oxidation number.
- 1.22 Calculate the Oxidation Number of underlined atoms in the following examples
a) $\underline{K}\underline{Mn}O_4$ b) $K_2\underline{Cr}_2O_7$ c) $\underline{H}NO_3$ d) $H_2\underline{S}O_4$ e) $\underline{Cl}O_4^-$ f) $\underline{N}H_4^+$
- 1.23 Differentiate between Oxidation Number and Valency

2.0 Calculate Molarity and Normality of given Solution

- 2.1 Define the terms 1. Solution, 2. Solute and 3. Solvent
- 2.2 Classify solutions based on physical state and solubility
- 2.3 Define mole
- 2.4 Problems on 'Mole concept'
- 2.5 Define the terms 1. Atomic weight, 2. Molecular weight and 3. Equivalent weight
- 2.6 Calculate Molecular weight and Equivalent weight of given Acids, (HCl, H_2SO_4 , HNO_3) Bases (NaOH, KOH, $Ca(OH)_2$) and Salts (NaCl, Na_2CO_3 , $CaCO_3$)
- 2.7 Define 1. Molarity, 2. Normality of solutions
- 2.8 Solve Numerical problem on Molarity and Normality
a) calculate the Molarity or Normality if weight of solute and volume of solution are given

b) calculate the weight of solute if Molarity or normality with volume of solution are given

c) problems on dilution to convert high concentrated solutions to low concentrated solutions

3.0 Understand the concepts of Acids and bases

- 3.1 Explain Arrhenius theory of Acids and Bases
- 3.2 State the limitations of Arrhenius theory of Acids and Bases
- 3.3 Explain Bronsted – Lowry theory of acids bases
- 3.4 State the limitations of Bronsted – Lowry theory of acids bases
- 3.5 Explain Lewis theory of acids and bases
- 3.6 State the limitations of Lewis theory of acids and bases
- 3.7 Explain the Ionic product of water
- 3.8 Define pH and explain Sorens on scale
- 3.9 Solve the Numerical problems on pH(Strong Acids and Bases)
- 3.10 Define Buffer solution
- 3.11 Give at least three examples for Buffer solutions
- 3.12 State the applications of Buffer solution

4.0 Understand the Principles of Metallurgy

- 4.1 List at least eight Characteristics of Metals
- 4.2 Distinguish between Metals and Non Metals
- 4.3 Define the terms 1.Mineral, 2.Ore, 3. Gangue, 4.Fluxand 5.Slag
- 4.4 Describe the methods of concentration of Ore; 1.Handpicking,2.Levigation, and3. Froth Floatation
- 4.5 Describe the methods involved in extraction of crude metal- Roasting, Calcination and Smelting.
- 4.6 Explain the purification of Metals by Electrolytic Refining
- 4.7 Define an Alloy
- 4.8 Write the Composition of the following alloys :1.Brass, 2 .Germansilver, 3 Nichrome
- 4.9 List the uses of the following Alloys: 1. Brass, 2.Germansilver, 3.Nichrome

5.0 Understand the concepts of Electrochemistry

- 5.1 Define the terms1. Conductor, 2. Insulator, 3.Electrolyte 4.Non–electrolyte
- 5.2 Distinguish between metallic conduction and Electrolytic conduction
- 5.3 Explain electrolysis by taking example fused NaCl
- 5.4 Explain Faraday’s laws of electrolysis

- 5.5 Define 1. Chemical equivalent (E) 2. Electrochemical equivalent (e) and their relation.
- 5.6 Solve the Numerical problems based on Faraday's laws of electrolysis
- 5.7 Define Galvanic cell
- 5.8 Explain the construction and working of Galvanic cell
- 5.9 Distinguish between electrolytic cell and galvanic cell
- 5.10 Explain the electrode potentials and standard electrode potentials
- 5.11 Explain the electro chemical series and its significance
- 5.12 Explain the emf of a cell.
- 5.13 Solve the numerical problems on emf of the cell based on standard electrode potentials.

6.0 Understand the concept of Corrosion

- 6.1 Define the term corrosion
- 6.2 state the Factors influencing the rate of corrosion
- 6.3 Describe the formation of a) composition cell, b) stress cell, c) concentration cell during corrosion.
- 6.4 Define rusting of iron and Explain the mechanism of rusting of iron.
- 6.5 Explain the methods of prevention of corrosion:
 - a) Protective coatings (anodic and cathodic coatings)
 - b) Cathodic protection (Sacrificial anode process and Impressed-voltage process)

7.0 Understand the concept of Water Technology

- 7.1 State the various Sources of water like Surface water and sub-surface water.
- 7.2 Define the terms soft water and hard water with respect to soap consumption.
- 7.3 Define the term hardness of water
- 7.4 Types of hardness of water 1. Temporary hardness 2. Permanent hardness
- 7.5 List the salts that causing hardness of water (with Formulae)
- 7.6 State the disadvantages of using hard water in industries
- 7.7 Define Degree of hardness, units of hardness (mg/L) or ppm.
- 7.8 Explain the methods of softening of hard water: a) Ion-Exchange process, b) Permutit process or zeolite process
- 7.9 Concept of Osmosis and Reverse Osmosis with examples .
- 7.10 State the applications of Reverse Osmosis.
- 7.11 State essential qualities of drinking water.

8.0 Understand the concepts of Polymers

- 8.1 Explain the concept of polymerisation

- 8.2 Describe the methods of polymerization a) addition polymerization of Ethylene b)condensation polymerization of phenol and formaldehyde(Only flow chart i.e. without chemical equations)
- 8.3 Define the term plastic
- 8.4 Classify the plastics with examples
- 8.5 Distinguish between the rmo and thermo setting plastics
- 8.6 List the Characteristics of plastics
- 8.7 State the advantages of plastics over traditional materials
- 8.8 State the disadvantages of using plastics.
- 8.9 Explain the methods of preparation of the following plastics:
1.Polythene, 2. PVC, 3.Teflon, 4. Polystyrene and 5. Urea formaldehyde
- 8.10 Explain the uses of the following plastics:
1.Polythene, 2. PVC, 3.Teflon, 4.Polystyrene and 5. Urea formaldehyde
- 8.11 Define the term natural rubber
- 8.12 write the structural formula of Natural rubber
- 8.13 Explain the processing of Natural rubber from latex
- 8.14 List the Characteristics of natural rubber
- 8.15 Explain the process of Vulcanization
- 8.16 List the Characteristics of Vulcanized rubber
- 8.17 Define the term Elastomer
- 8.18 Describe the preparation of the following synthetic rubbers a) Buna-s and b)Neo prene rubber
- 8.19 List the uses of the following synthetic rubbers a) Buna-s and b)Neo prene rubber

9.0 Understand the concepts of Fuels

- 9.1 Define the term fuel
- 9.2 Classify the fuels based on physical state—solid, liquid and gaseous fuels,
- 9.3 Classify the fuels based on occurrence-primary and secondary fuels
- 9.4 List the characteristics of good fuel
- 9.5 State the composition and uses of gaseous fuels:
a)water gas, b)producer gas, c)natural gas, d)coal gas, e)Biogas and f) acetylene

B. ENVIRONMENTALSTUDIES

- 1.1 Define the term environment
- 1.2 Explain the scope and importance of environmental studies
- 1.3 Segments of environment 1).Lithosphere, 2).Hydrosphere, 3).Atmosphere, 4).Biosphere,
- 1.4 Define the following terms 1)Pollutant, 2).Pollution, 3).Contaminant, 4)receptor, 5)sink, 6) particulates, 7)dissolved oxygen, 8)Threshold limit value, 9).BOD, and 10).COD 11) eco system .
- 1.5 State the renewable and non renewable energy sources with examples.
- 1.6 Define the terms:
1) .Producers, 2) .Consumers and 3) .D ecomposers with examples.

- 1.7 Explain bio diversity and threatst obiodiversity
- 1.8 Define air pollution
- 1.9 Classify the air pollutants-based on origin and physical state of matter.
- 1.10 Explain the causes of Air pollution.
- 1.11 Explain the effects of air pollution on human beings, plants and animals.
- 1.12 State the uses of forest resources.
- 1.13 State the deforestation and its causes and effects.
- 1.14 Explain the 1.) Green house effect , 2) Ozone layer depletion and 3) Acidrain.
- 1.15 Explain the methods of control of Air pollution
- 1.16 Define Water pollution
- 1.17 Explain the causes of Water pollution
- 1.18 Explain the effects of Water pollution on living and Non-living things.
- 1.19 Explain the methods of control of Water pollution.

COURSE CONTENT

A. ENGINEERINGCHEMISTRY

1. Fundamentals of Chemistry

Atomic Structure: Introduction - Fundamental particles – Bohr’s theory – Quantum numbers – Aufbau principle - Hund’s rule - Pauli’s exclusion Principle- Orbitals, shapes of s, p and d orbitals - Electronic configurations of elements

Chemical Bonding: Introduction – types of chemical bonds – Ionic and covalent bond with examples–Properties of Ionic and Covalent compounds- structures of ionic crystals NaCl, CsCl.

,**Oxidation Number**- calculations, differences between Oxidation Number and Valency.

2. Solutions

Introduction-concentration methods – Mole concept, Molarity, Normality, Equivalent weights, Numerical problems on Mole, Molarity and Normality.

3. Acids and Bases

Introduction – Theories of acids and bases and limitations – Arrhenius theory-Bronsted –Lowry theory – Lewis acid base theory – Ionic product of water– pH and related numerical problems– Buffer solutions–Applications.

4. Principles of Metallurgy

Characteristics of Metals and distinction between Metals and Non Metals, Metallurgy, ore, Gangue, Flux, Slag - Concentration of Ore –Hand picking, Levigation, Froth floatation – Methods of Extraction of crude Metal – Roasting, Calcination, Smelting – Alloys – Composition and uses of Brass, German silver and Nichrome

5. Electrochemistry

Conductors, insulators, electrolytes– electrolysis – Faraday’s laws of electrolysis- numerical problems – Galvanic cell – standard electrode potential – electrochemical series–emf and

numerical problems on emf of a cell

6. Water technology

Introduction—soft and hard water—causes of hardness—types of hardness

—disadvantages of hard water – degree of hardness (ppm) – softening methods – permutit process – ion exchange process—drinking water –Osmosis, Reverse Osmosis –Applications of Reverse osmosis

7. Introduction - factors influencing corrosion - composition, stress and concentration cells—rusting of iron and its mechanism – prevention of corrosion by coating methods, cathodic protection

8. Polymers

Introduction – polymerization – types of polymerization – addition, condensation with examples – plastics – types of plastics – advantages of plastics over traditional materials –

Disadvantages of using plastics – preparation and uses of the following plastics: 1. Polythene 2. PVC 3. Teflon 4. Polystyrene 5. Urea formaldehyde – Rubber – Natural rubber – processing from latex –Vulcanization – Elastomers, Buna-s, Neoprene rubber and their uses.

9. Fuels

Definition and classification of fuels—characteristics of good fuel—composition and uses of gaseous fuels.

B. ENVIRONMENTAL STUDIES

Introduction— environment –scope and importance of environmental studies important terms—renewable and non-renewable energy sources—Concept of ecosystem, producers, consumers and decomposers – Biodiversity, definition and threats to Bio diversity.

Air pollution – causes—Effects— forest resources: uses and over exploitation, deforestation, acid rain, greenhouse effect –ozone depletion – control of air pollution – Water pollution – causes – effects – control measures,

REFERENCE BOOKS

1. Intermediate chemistry Vol 1&2 Telugu Academy
2. Intermediate chemistry Vol 1&2 Vikram Publishers
3. Intermediate chemistry Vol 1&2 Vignam Publishers & Deepthi Publishers
4. Engineering Chemistry Jain & Jain
5. Engineering Chemistry O.P. Agarwal, Hi-Tech.
6. Engineering Chemistry Sharma
7. Engineering Chemistry A.K. De

Mineral Processing Technology

Subject Title : **Mineral Processing Technology**
Subject code : **Met – 105**
Periods/week : **04**
Periods/Year : **120**

TIME SCHEDULE

S.No	Major Topics	Periods	Weightage of Marks	Short Type	Essay
					Type
1	Ores & ore dressing	12	09	3	-
2	Ore sampling	14	13	1	1
3	Comminution	20	26	2	2
4	Sizing	16	13	1	1
5	Classification	18	13	1	1
6	Concentration	20	26	2	2
7	Concentration processes of some important ores.	20	10	0	1
	Total	120	110	10	8

OBJECTIVES:

After the completion of course the student should be able to comprehend the following:

1.0 Ores & ore dressing

- 1.1 Define Native Metal, Mineral, Ore & Ore Dressing.
- 1.2 Know the minerals of commercially important Metals such as Iron, Al, Cu, Zn., Mg., Ti., U., Th., Pb, Sn,.
- 1.3 Knowl the metal content & chemical composition of the minerals of the above Metals.
- 1.4 Know the advantages of mineral / ore dressing.
- 1.5 State the Important operations of Ore Processing.

2.0 Ore Sampling

- 2.1 State the need for study of ore sampling.
- 2.2 Define sample & sampling.
- 2.3 State the rules for sampling.
- 2.4 Classify the sampling operations
- 2.5 List the types of hand sampling methods.
- 2.6 Explain Grab, Trench, pipe sampling and coning & Quartering and Fractional selections.
- 2.7 Explain the principle of mechanical sampling.
- 2.8 Explain the working principle of Vezin sampler

3.0 Comminution

- 3.1 Define Comminution & State the objectives of Comminution.
- 3.2 Classify the Comminution processes.
- 3.3 State the principles of crushing
- 3.4 Classify the crushing operations.
- 3.5 Explain the working principle & operation of Blake & Dodge Jaw Crushers

- 3.6 Explain the working principle & operation of roll crusher.
- 3.7 Define 'Angle of NIP' of roll crusher.
- 3.8 Derive an equation for angle of NIP.
- 3.9 Define grinding & Compare crushing & grinding.
- 3.10 Classify the Grinding Mills.
- 3.11 Explain the working principle & operation of Spherical / Conical Ball Mill.
- 3.12 State the Laws of Comminution - Rittinger's ,Kick's and Bond's laws.

4.0 Sizing

- 4.1 Understand the importance of sizing.
- 4.2 Know the sizing Methods.
- 4.3 Define screening & Classify
- 4.4 Define Mesh number & Mesh Size
- 4.5 Know designating the Mesh numbers as Per ISI.
- 4.6 Explain the method of making screen analysis by Rotap sieve shaker.
- 4.7 Tabulate the results of screen analysis by direct plot & cumulative plot methods.
- 4.8 Know the types of Industrial screens.
- 4.9 State the equation for capacity of screens.
- 4.10 Know the factors effecting the capacity of screens.

5.0 Classification

- 5.1 Know the movement of solids in fluids – Principles of free settling and hindered settling.
- 5.2 Know about Laminar and turbulent flow of fluids ,Reynolds Number and its expression.
- 5.3 Know the principle of classification
- 5.4 Know the mechanism of classification in relation to Stoke's law of settling.
- 5.5 Explain the working principle of Dorr rake classifier and of hydrocyclone classifier

6.0 Concentration

- 6.1 Define Concentration & State the objectives of Concentration
- 6.2 State the principles of Concentration.
- 6.3 Define concentrate, tailing & middling.
- 6.4 Classify the concentration operations.
- 6.5 Explain the working principle of magnetic separator.
- 6.6 List the gravity concentration processes.
- 6.7 Explain the sink & float technique.
- 6.8 Explain the working principle of tabling.
- 6.9 Explain the principle of jigging.
- 6.10 Explain the jigging process. (Harz Jig only).
- 6.11 Define froth flotation.
- 6.12 Explain the flotation process.
- 6.13 Define the froather, collector, activator, depressor & conditioner with suitable examples.
- 6.14 Explain the operation of Denver flotation cell
- 6.15 Electrostatic separation –principle and operation.

7.0 Concentration processes of some important ores

- 7.1 Know and explain the flow sheet of bauxite ore processing.
- 7.2 Know and explain the flow sheet of coal washing.
- 7.3 Know and explain the flow sheet of iron ore processing
- 7.4 Know and explain the flow sheet of gold ore processing.
- 7.5 Know and explain the flow sheet of lead/zinc concentration.

COURSE CONTENTS:

1.0 ORES AND ORE DRSSING:

Definition of native metal,mineral, ore & ore dressing, minerals of commercially important metals, metal content and chemical composition of the important ores, advantages of ore dressing,important operations of ore dressing.

2.0 ORE SAMPLING:

Introduction- Rules for sampling –classification-Hand sampling methods-principle of Mechanical sampling.

3.0 COMMINATION:

Introduction – stages of crushing, primary crushing: Blake type jaw crusher-secondary crushing: Roll crusher- Angle of Nip of Roll crusher –grinding: Definition & classification- Ball mill – comparison of crushing & grinding. Laws of Comminution.

4.0 SIZING:

Introduction – sizing methods- screening types- mesh size & mesh number- ISI Designation of mesh number-screen analysis by Rotap sieve shake –tabulation of results-capacity of screen and effecting factors.

5.0 CLASSIFICATION:

Introduction –movement of solids in fluids-free settling,hindered settling ,laminar flow ,turbulrntflow,Reynolds number-derivation,principle of classification,Stoke’s law of settling – mechanism of classification,working principle of mechanical classifier Dorr’s classifier and centrifugal classifier Hydrocyclone classifier.

6.0 CONCENTRATION:

Introduction-principles of concentration-Definitions of concentrate, tailing & middling – concentration Methods-Magnetic separator- gravity concentrations processes-sink & float technique, tabling, Jigging- froth flotation – process & additives.

7.0 CONCENTRATION OF SOME IMPORTANT ORES:

Explanation about the processing of aluminium ore – bauxite - flow sheet, Processing of coal-main operations and flow sheet,Main concentration processes of iron ores - flow sheet,Floatation of gold ores – flow sheet.Concentration flow sheet of lead/zinc.

Reference Books:

- | | | | |
|----|-----------------------------------|---|--------------------------|
| 1. | Principles of Mineral Dressing | - | Gaudin |
| 2. | Elements of metallurgy | - | Dr.Swaroop |
| 3. | Ore Dressing | - | S.K. Jain |
| 4. | Non-Ferrous extractive Metallurgy | - | Ray. Abraham and Sridhar |

Elements of Metallurgical Engineering

Subject Title : Elements of Metallurgical Engineering
Subject code : Met – 106
Periods/week : 04
Periods/Year : 120

TIME SCHEDULE

S.No	Major Topics	Periods	Wweightage of Marks	Short Type	Essay
					Type
1	Introduction to metallurgy	15	09	3	0
2	Ferrous, nonferrous metals and their alloys.	20	23	1	2
3	Principles of extractive metallurgy-pyro metallurgy	22	23	1	2
4	Principles of extractive metallurgy-Hydrometallurgy	18	13	1	1
5	Principles of extractive metallurgy-Electrometallurgy	20	16	2	1
6	Manufacturing processes	25	26	2	2
	Total	120	110	10	08

OBJECTIVES

After the completion of course the student should be able to comprehend the following:

1.0 Introduction to metallurgy.

- 1.1 Define material and classify them.
- 1.2 Define metal and state it's properties.
- 1.3 Classify the metals.
- 1.4 Define metallurgy and state its importance.
- 1.6 Classify the divisions of metallurgy and explain them.
- 1.9 State the economic importance of metallurgical Industries.
- 1.10 List out important metal extraction plants in India.
 - a) Integrated Iron & steel plants.
 - b) Aluminium plants
 - c) Copper plants
 - d) Zinc & lead plants.

2.0 Ferrous, Non-Ferrous Metals and their alloys

- 2.1 State the basis of classification of plain carbon steels.
- 2.2 List out the applications of the steels.
- 2.3 State the need for alloying the steel with other elements.
- 2.4 State the composition, properties and industrial applications of alloy steels.
- 2.5 Know the properties of tool steels
- 2.6 Know the composition and properties of high speed tool steels.
- 2.7 Know the composition of special cutting materials like satellites, cemented carbides

- 2.8 Know the classification of cast irons – Gray, white, malleable, spheroidal- composition, properties and applications.
- 2.9 Know the need for non-ferrous metals and their alloys in engineering application.
- 2.10 List out the composition, properties, and industrial application of the important– Non-ferrous alloys like brass, bronze, muntz metal.
- 2.11 Know the properties of bearing metals.
- 3.0 Principles of extractive metallurgy - Pyrometallurgy**
- 3.1 State the salient features of extractive metallurgy
- 3.2 Define the pyrometallurgy& List the Pyrometallurgy operations.
- 3.4 Explain drying.
- 3.5 Explain calcination.
- 3.6 Define roasting & classify the roasting operation.
- 3.7 Explain the oxidizing, blast, and sulphatise, Autogeneous roasting with chemical reactions.
- 3.8 Explain multiple hearth roaster, Flash roaster & fluidised Bed Roaster.
- 3.9 Define smelting.
- 3.10 Define Flux, Slag, Matte.
- 3.11 Classify smelting operations
 - a) Reduction Smelting – Carbothermic&Metallothermic
 - b) Matte Smelting.
- 3.12 State the importance of Coke as a reducing agent in Carbothermic Reduction
- 3.13 Define refining & State the purpose of refining.
- 3.14 List important methods of Refining
- 3.15 Define Drossing& fire refining.
- 3.16 Explain Zone Refining.
- 4.0 Principles of extractive metallurgy - Hydrometallurgy**
- 4.1 Define Hydrometallurgy.
- 4.2 State advantages & Limitations of Hydro Metallurgy
- 4.3 List important stages in Hydro Metallurgy
- 4.4 Define leaching & identify the materials for leaching
- 4.5 State the properties of leachant.
- 4.6 List important Leaching operations
- 4.7 Explain pressure, bacterial, ammonical, Acid & heap leaching.
- 4.8 Define precipitation.
- 4.9 Understand briefly the typical flow sheet of Hydrometallurgy.
- 5.0 Principles of extractive metallurgy - Electro metallurgy**
- 5.1 Define electro metallurgy.
- 5.2 State advantages & Limitations of electro Metallurgy
- 5.3 Classify Electro Metallurgical operations
- 5.4 Define Electrolysis
- 5.5 State Faraday's laws of Electrolysis.
- 5.6 State the principle of electrolysis w.r.t. to Anodic &cathodic reactions
- 5.7 Explain the electrolysis of molten salts.
- 5.8 Explain the electrolysis of aqueous solutions.
- 5.9 State Principle of electrolytic refining.
- 5.10 State applications of Electrolytic Refining
- 5.11 State the Principle of Electro Plating
- 5.12 State the commercial applications of electroplating.

6.0 Manufacturing Processes:

- 6.1 Know about melting process.,
- 6.2 Know the different furnaces used for melting like cupola, reverberatory, induction,arc.
- 6.2 Define casting.
- 6.3 State different casting processes like ingot casting,sandcasting,die casting.
- 6.3 State rolling operation,
- 6.4 Know about different types of rolling mills,
- 6.5 Know the tube making process by using rolling operation.
- 6.6 State the principle of forging,
- 6.7 Know the types of forging hammers and press,smith forging ,closed die forging.
- 6.8 Know the extrusion process by direct method,and by indirect method.
- 6.9 Know about different drawing processes– Rod drawing,wiredrawing,deep drawing.
- 6.10 Know about powder metallurgy process – Production of metal powders,powder mixing, sintering compacting of powders into shapes,
- 6.11 State the applications of powder metallurgy..

COURSE CONTENTS:

1.0 INTRODUCTION TO METALLURGY:

Materials classification, metal properties &classification, divisions of metallurgy, economic Importance of metallurgical industries, important metal extraction plants in India.

2.0 FERROUS, NON FERROUS METALS AND THEIR ALLOYS:

Classification of steels and their applications. Need for alloying steels, different alloy steels – their properties, applications. Properties of tool steels, Properties and composition of high speed tool steel, Composition of special cutting steels – satellites and cemented carbides. Different cast irons – gray, whitemalleable, spheroidal – composition, properties and their applications. Important non ferrous metals brass, bronze, muntz metals – their compositions, properties and applications. Properties of bearing metals.

3.0 PYRO METALLURGY:

Introduction- Types of pyro metallurgical operations- Drying, calcination and Roasting., Classification of roasting operations Multiple hearth roaster, Flash Roaster & fluidised bed roaster. Smelting: Types of smelting-principle of Reduction smelting & Matte smelting Refining: Definition & purpose -Types of refining: Dressing, fire reeling & Zone refining

4.0 HYDRO METALLURGY:

Introduction – leaching- properties of leachant –suitable Materials for leaching- types of leaching methods – precipitation-Typical flow sheet of Hydro metallurgy.

5.0 ELECTRO METALLURGY:

Introduction- electrolysis :Definition& principle- cathodic& anodic reactions of electrolysis Faraday's laws of electrolysis- electrolysis of molten salt &aqueous solutions- Electrolytic refining: principle & applications- Electro plating: principle &applications.

6.0 MANUFACTURING PROCESSES:

Melting process, different furnace used for melting – cupola, reverberatory, induction, arc., Definition of casting, various casting processes – ingot, sand, die .,Rolling operation, different rollingmills,tube making process by rolling.,Principle of forging,different types of forging hammers and press ,smith forging and closed die forging.Process of extrusion by direct method and indirect method.,Different drawing processes – rod drawing,wiredrawing,deep drawing.,Powder metallurgy processes – production of metal powders,powder mixing, sintering and compacting of powders into shapes.,Powder metallurgy applications.

Books Recommended:

- | | | | |
|----|-----------------------------------|----|--------------------------|
| 1. | Principles of Mineral Dressing | - | Gaudin |
| 2. | Elements of metallurgy | - | Dr.Swaroop |
| 3. | Ore Dressing | - | S.K. Jain |
| 4. | Non-Ferrous extractive Metallurgy | - | Ray. Abraham and Sridhar |
| 5. | Engineering Metallurgy PartI | I- | R.A.Higgins |

ENGINEERING DRAWING

Subject Title	:	Engineering Drawing
Subject Code	:	107 (Common to all Branches)
Periods/Week	:	06
Periods Per Year	:	180

Time Schedule

Sno	Major Topics	No. of Periods	Weightage of marks	Short Answer Questions	Essay type Questions
1	Importance of Engineering Drawing	01	-	-	-
2	Engineering Drawing Instruments	05	-	-	-
3	Free hand lettering & Numbering	06	5	1	-
4	Dimensioning Practice	09	5	1	-
5	Geometrical Constructions	21	15	1	1
6	Projection of points, Lines, Planes & Solids	21	10	-	1
7	Auxiliary views	06	5	1	-
8	Sectional views	27	10	-	1
9	Orthographic Projection	33	10	-	1
10	Pictorial drawing	30	10	-	1
11	Development of surfaces	21	10	-	1
	Total	180	80	04	06

The course is aimed at developing basic graphic skills so as to enable them to use these skills in preparation of engineering drawings, their reading and interpretation

OBJECTIVES

Upon completion of the subject the student shall be able to

- 1) Understand the basic concepts of Engineering Drawing

- a) State the importance of drawing as an engineering communication medium
- b) State the necessity of B.I.S. Code of practice for Engineering Drawing
- c) Explain the linkages between Engineering drawing and other subjects of study in diploma course

2) Use of Engineering Drawing Instruments

- a) Select the correct instruments and draw lines of different orientation
- b) Select the correct instruments and draw small and large Circles
- c) Select the correct instruments for measuring distances on the drawing
- d) Use correct grade of pencil for different types of lines, thickness and given function
- e) Select and use appropriate scales for a given application
- f) Identify different drawing sheet sizes as per I.S. and Standard Layouts
- g) Prepare Title block as per B.I.S. Specifications
- h) Identify the steps to be taken to keep the drawing clean and tidy

3) Write Free Hand Lettering and Numbers

- a) Write titles using slanting letters and numerals of 7mm, 10mm and 14mm height
- b) Write titles using vertical letters and numerals of 7mm, 10mm and 14mm height
- c) Select suitable sizes of lettering for different layouts and applications

4) Understand Dimensioning Practice

- a) Define "Dimensioning"
- b) State the need of dimensioning the drawing according to accepted standards
- c) Identify notations of Dimensioning used in dimensioned drawing
- d) Identify the system of placement of dimensions in the given dimensioned drawing
- e) Dimension a given drawing using standard notations and desired system of dimensioning
- f) Dimension standard features applying necessary rules
- g) Arrange dimensions in a desired method for a given drawing
- h) Identify the departures if any made in the given dimensioned drawing with reference to SP-46-1988, and dimension the same correctly

5) Apply Principles of Geometric Constructions

- a) Divide a given line into desired number of equal parts internally
- b) Draw tangent lines and arcs
- c) Use General method to construct any polygon
- d) Explain the importance of conics
- e) Construct ellipse by concentric circles method
- f) Construct parabola by rectangle method
- g) Construct rectangular hyperbola from the given data
- h) Construct involute from the given data
- i) Construct cycloid and helix from the given data
- j) State the applications of the above constructions in engineering practice

6) Apply Principles of Projection of points, lines, planes & solids

- a) Visualize the objects
- b) Explain the I-angle and III-angle projections
- c) Practice the I-angle projections
- d) Draw the projection of a point with respect to reference planes (HP&VP)
- e) Draw the projections of straight lines with respect to two reference planes (cases of lines parallel to one plane and inclined to other plane only)
- f) Draw the projections of planes (cases of planes perpendicular to one plane and inclined to other plane only)

- g) Draw the projections of solids (cases of axis perpendicular to one plane and inclined to other plane only)
- 7) Understand the need of auxiliary views**
 - a) State the need of Auxiliary views for a given engineering drawing
 - b) Draw the auxiliary views of a given engineering component
 - c) Differentiate between auxiliary view and apparent view
- 8) Appreciate the need of Sectional Views**
 - a) Explain the need to draw sectional views
 - b) Select the section plane for a given component to reveal maximum information
 - c) Explain the positions of section plane with respect to reference planes
 - d) Differentiate between true shape and apparent shape of section
 - e) Draw sectional views and true sections of regular solids discussed in chapter-6 above
 - f) Apply principles of hatching
- 9) Apply principles of orthographic projection**
 - a) Explain the principles of orthographic projection with simple sketches
 - b) Draw the orthographic view of an object from its pictorial drawing
 - c) Draw the minimum number of views needed to represent a given object fully
- 10) Prepare pictorial drawings**
 - a) State the need of pictorial drawings
 - b) Differentiate between isometric scale and true scale
 - c) Prepare Isometric views for the given orthographic drawings
- 11) Interpret Development of surfaces of different solids**
 - a) State the need for preparing development drawing
 - b) Prepare development of simple engineering objects (cubes, prisms, cylinders, cones, pyramids) using parallel line and radial line methods
 - c) Prepare development of surface of engineering components like trays, funnels, 90° elbows & rectangular ducts

COURSE CONTENT

NOTE

- 1) B.I.S Specifications should invariably be followed in all the topics.**
- 2) A-3 Size Drawing Sheets are to be used for all Drawing Practice Exercises.**
- 3) First Angle Projection is to be followed for all Orthographic projection exercises**

1) The importance of Engineering Drawing

Explanation of the scope and objectives of the subject of Engineering Drawing, Its importance as a graphic communication -Need for preparing drawing as per standards – SP-46–1988 – Mention B.I.S - Role of drawing in engineering education – Link between Engineering drawing and other subjects of study

2) Engineering drawing Instruments

Classification: Basic tools, tools for drawing straight lines, tools for curved lines, tools for measuring distances and special tools like mini drafter & drafting machine – Mention the names under each classification and their brief description -Scales: Recommended scales reduced & enlarged scales- Lines: Types of lines, selection of line thickness - Selection of Pencils -Sheet Sizes: A0, A1, A2, A3, A4,

A5, Layout of drawing sheets in respect of A0, A1, A3 sizes, Sizes of the Title block and its contents - Care and maintenance of Drawing Sheet

Drawing Plate 1: Consisting of two exercises on use of drawing instruments

3) Free hand lettering & numbering

Importance of lettering – Types of lettering -Guide Lines for Lettering- Practicing letters & numbers of given sizes (7mm, 10mm and 14mm) Advantages of single stroke or simple style of lettering

Drawing plate 2: Consisting of five to six exercises on freehand Lettering & Numbering

4) Dimensioning practice

Purpose of engineering Drawing, Need of B.I.S code in dimensioning -Shape description of an Engineering object - Dimensioning size, Location features, surface finish, fully dimensioned Drawing - Notations or tools of dimensioning, dimension line, extension line, leader line, arrows, symbols, number and notes, rules to be observed in the use of above tools - Placing dimensions: Aligned system and unidirectional system (SP-46- 1988) - Arrangement of dimensions: Chain, parallel, combined, progressive, and dimensioning by co-ordinate methods - The rules for dimensioning standard features Circles (holes) arcs, angles, tapers, chamfers, and dimensioning of narrow spaces

Drawing Plate 3: Consisting of 8 exercises on Dimensioning methods and rules

5) Geometric Constructions

Division of a line: to divide a straight line into given number of equal parts internally and it's examples in engineering applications. Construction of tangent lines: to draw tangent lines touching circles internally and externally. Construction of tangent arcs i) To draw tangent arc of given radius to touch two lines inclined at given angle (acute, right and obtuse angles) ii) Tangent arc of given radius touching a circle or an arc and a given line iii) Tangent arcs of radius R, touching two given circles internally and externally Construction of polygon: Construction of any regular polygon of given side using general method. Conical Curves: Explanation of Ellipse, Parabola, Hyperbola, as sections of a double cone and loci of a moving point, Eccentricity of above curves – Their Engg. applications viz. Projectiles, reflectors, P-V Diagram of a Hyperbolic process - Construction of ellipse by concentric circles method - Construction of parabola by rectangle method - Construction of rectangular hyperbola - General Curves: Involute, Cycloid and Helix, explanations as locus of a moving point, their engineering applications, viz, Gear tooth profile, screw threads, springs etc. - their construction.

Drawing Plate 4: Consisting of eight exercises on construction of polygons

Drawing Plate 5: Consisting of eight exercises on construction of conics

Drawing Plate 6: Consisting of eight exercises on involute, cycloid and helix

6) Projection of points, lines, planes & solids

Projecting a point on two planes of projection -Projecting a point on three planes of projection - Projection of straight line i) Parallel to both the planes ii) Perpendicular to one of the planes iii) Inclined to one plane and parallel to other plane - Projection of regular planes- i) Plane perpendicular to HP and parallel to VP and vice versa ii) Plane perpendicular to HP and inclined to VP and vice versa - Projection of regular solids with i) Axis perpendicular to one of the planes ii) Axis parallel to VP and inclined to HP and vice versa

Drawing Plate 7: Consisting of eight exercises on projection of points and Lines

Drawing Plate 8: Consisting of eight exercises on projection of planes

Drawing Plate 9: Consisting of eight exercises on projection of solids

7) Auxiliary views

Need for drawing auxiliary views - Explanation of the basic principles of drawing auxiliary views, explanation of reference plane and auxiliary plane - Partial auxiliary view.

Drawing plate 10: Consisting of four exercises on auxiliary views

8) Sectional views

Need for drawing sectional views – what is a sectional view - Location of cutting plane – Purpose of cutting plane line – Selection of cutting plane to give maximum information (vertical and offset planes) - Hatching – Section of regular solids inclined to one plane and parallel to other plane

Drawing Plate 11: Consisting of six exercises on sections of solids

9) Orthographic Projections

Meaning of orthographic projection -Using a viewing box model – Number of views obtained on the six faces of the box, - Legible sketches of only 3 views for describing object - Concept of front view, top view, and side view, sketching these views for number of engineering objects - Explanation of first angle projection. – Positioning of three views in First angle projection - Projection of points as a means of locating the corners of the surfaces of an object – Use of mitre line in drawing a third view when other two views are given - Method of representing hidden lines - Selection of minimum number of views to describe an object fully

Drawing Plate 12: Consisting of 12 exercises on orthographic projections of engineering objects

10) Pictorial Drawings

Brief description of different types of pictorial drawing viz., Isometric, oblique, and perspective and their use - Isometric drawings: Iso axis, angle between them, meaning of visual distortion in dimensions - Need for an isometric scale, difference between Isometric scale, and ordinary scale-difference between Isometric view and Isometric projection - Isometric and Non-isometric lines - Isometric drawing of common features like rectangles, circular shapes, non-isometric lines - Use of box and offset methods

Drawing plate 13: Consisting of 12 exercises on Isometric views of engineering objects

11) Development of Surfaces

Need for preparing development of surface with reference to sheet metal work -Concept of true length of a line with reference to its orthographic projection when the line is (i) parallel to the plane of projection (ii) inclined to one principal plane and parallel to the other -Development of simple solids like cubes, prisms, cylinders, cones, pyramids -Types of development: Parallel line and radial line development -Procedure of drawing development - drawings of trays, funnels, 90° elbow pipes and rectangular ducts.

Drawing plate 14: Consisting of 5 exercises on development problems

REFERENCE BOOKS

Engineering Graphics by P I Varghese – (McGraw-hill)

Engineering Drawing by Basant Agarwal & C.M Agarwal - (McGraw-hill)

Engineering Drawing by N.D.Bhatt.

T.S.M. & S.S.M on “ Technical Drawing” prepared by T.T.T.I., Madras.

SP-46-1998 – Bureau of Indian Standards.

WORK SHOP PRACTICE

Subject Title	:	Workshop Practice
Subject Code	:	Met – 108
Periods/Week	:	03
Periods/Year	:	90

TIME SCHEDULE

S.No	Major topics	Periods
1	Carpentry	15
2	Forging	15
3	Fitting	15
4	Machine shop	15
5	Welding	30
	Total	90

Carpentry

1. Practice on planning, sawing and chiselling.
2. Prepare a half lap joint.
3. Prepare a Dovetail joint.
4. Prepare a Mortise joint.
5. Prepare a 20 cm x 15cm teak wood switch board with hinges and bottom hook.
6. Fix the laminate sheet to the above box and cut suitable holes to mount one flush type switch, socket.

FORGING SHOP

- 1 Conversion of Round to square.
- 2 Conversion of Round to Hexagon.
- 3 Preparation of Chisel from round rod.
- 4 Preparation of ring and hook from M.S. Round.
- 5 Preparation of a hexagonal bolt and nut.

Fitting

- 1 Marking and chipping on Mild – steel flat 12 mm thick.
- 2 Cutting with hack saw, M.S. Flats of 6 mm thick.
- 3 Marking, cutting, drilling, Chamfering and tapping on a M.S. Flat 12 mm thick.
- 4 Assembling of two pieces, Matching by filing (6 mm thick M.S. Plate)
5. Cut a G.I pipe and solid rod using hack saw.
6. Thread cutting of G.I. pipe, metal conduit and solid rod using die set

- Internal thread cutting using tap set and cleaning the threads using reamers and make a hexagonal nut from a round rod.

Machine shop

- Turn the given rod to get three different diameters using lathe.
- Make a bolt and cut threads using lathe.
- Cut the threads to G.I. pipe using lathe.
- Prepare a centre punch and knurl its head.
- Make a square plate using power hawk saw, remove sharp edges using grinder, mark triangle and drill three holes of different diameters at the vertices.


Welding

- Handle the gas welding torch for welding
- Handle the Electrode Holder for laying welding beads.
- Understand the operation of welding transformer and generator.
- Perform various welding joint operations.
- Perform spot welding operations

KEY competencies to be achieved by the student.

Carpentry

Title of the Job	Key Competency
Practice on planning, sawing and chipping	Identify dimensions of the job(LXBW) Planning and surface finishing using jack planner. Based on measurement sawing or cutting. Chipping(removal of excess material or internal cutting)
Prepare a half lap joint	Planning using metal jack planer or wooden jack planer. Cutting using hand saw or cross cut saw. Chiseling(measurement of center portion) Smoothing the surface using rasp file. Joint would be square shape.

Prepare a Dovetail joint	Planning using metal jack planer. Cutting using cross cut saw. Chiseling with the help of mallet. Joint would be in this shape 
Prepare a Mortise joint	Dimensions of teak wood job 25*45*150mm of 2 pieces. Measurement of appropriate dimensions using mortise gauge.
Prepare a 20cmX 15 cm teak wood switch board with hinges and bottom hook	Prepare wooden box of dimensions 20*15cms. Planning, cutting, and chiseling. Mark appropriate Hand drills to produce holes.
Fix the laminate sheet to the above box and cut suitable holes to mount flush type switch, socket	

FORGING SHOP

Title of the Job	Key Competency
Conversion of Round to Square	<ul style="list-style-type: none"> – Heat the specimen to the appropriate temperature – Identify the holding and striking tools – Hammer the specimen to the required shape
Conversion of Round to Hexagon	<ul style="list-style-type: none"> – Heat the specimen to the appropriate temperature – Identify the holding and striking tools – Hammer the specimen to the required shape
Preparation of a Chisel from round rod	<ul style="list-style-type: none"> – Heat the specimen to the appropriate temperature – Identify the holding and striking tools – Hammer the specimen to the required shape

Preparation of a ring and hook from M.S round	<ul style="list-style-type: none"> – Heat the specimen to the appropriate temperature – Identify the holding and striking tools – Hammer the specimen to the required shape
Preparation of a hexagonal bolt and nut	<ul style="list-style-type: none"> – Heat the specimen to the appropriate temperature – Identify the holding and striking tools – Upset the cylindrical rod – Hammer the specimen to the required shape

FITTING SHOP

Title of the Job	Key Competency
Marking and Chipping on Mild steel flat of 12 mm thick	<ul style="list-style-type: none"> – Identify appropriate measuring tool – Handle appropriate marking tool – Handle appropriate chipping tool – Mark the dimensions – Remove the material by chipping from MS flats
Cutting with hack saw of MS flats of 6mm thick	<ul style="list-style-type: none"> – Use the hack saw while cutting MS flats – Load and unload hack saw blade from its frame
Marking, Cutting, drilling, chamfering and tapping on a MS flat of 12 mm thick	<ul style="list-style-type: none"> – Locate the hole on M.S. plate – Identify appropriate drill bit – Load and unload drill bit from the machine – Identify appropriate taps – State the specifications of taps and drill – Tap the hole
Assembling of two pieces, matching by filing	<ul style="list-style-type: none"> – Identify appropriate file – State the specifications of a file – File the specimen

FORGING SHOP

Title of the Job	Key Competency
Conversion of Round to Square	<ul style="list-style-type: none">– Heat the specimen to the appropriate temperature– Identify the holding and striking tools– Hammer the specimen to the required shape
Conversion of Round to Hexagon	<ul style="list-style-type: none">– Heat the specimen to the appropriate temperature– Identify the holding and striking tools– Hammer the specimen to the required shape
Preparation of a Chisel from round rod	<ul style="list-style-type: none">– Heat the specimen to the appropriate temperature– Identify the holding and striking tools– Hammer the specimen to the required shape
Preparation of a ring and hook from M.S round	<ul style="list-style-type: none">– Heat the specimen to the appropriate temperature– Identify the holding and striking tools– Hammer the specimen to the required shape
Preparation of a hexagonal bolt and nut	<ul style="list-style-type: none">– Heat the specimen to the appropriate temperature– Identify the holding and striking tools– Upset the cylindrical rod– Hammer the specimen to the required shape

Machine shop

Title of the Job	Key Competency
Turn the given rod to get three different diameters using lathe	25*100mm M.S Round Rod. Hold job in chuck. Marking, step turning.
Make a bolt and cut threads using lathe	16mm Rod (M.S) Holding, Marking, Threading.

Cut the threads to G.I. pipes using lathe	Cut Threads on Circumference of G.I Pipe. 20*100mm G.I Pipe. Align Job by Holding it in Chuck, Thread Cutting & Checking with Screw Gauge.
Prepare a centre punch and knurl its head	Manufacture of center punch on lathe. 20*100mm M.S. Round Plain Turning, Taper, Knurling, Chamfering.
Make a square plate using power hawk saw, remove sharp edges using grinder, mark triangle and drill three holes of different diameters at the vertices	6mm Plate*50*50mm M.s Flat, Drilling Holes of Different Dia at Vertices of Triangle.

Welding

Title of the Job	Key Competency
Handle the gas welding torch for welding	Study the various Parts of Gas Welding/Equipment. Know the handling of Gas Torch & Cylinders.
Handle the Electrode holder for laying welding beads	Fix the Electrode in the Clamp. Perform the Welding operations.
Understand the operation of welding transformer and generator	Study the principle of Welding Transformer/Generator. Know the working of Welding transformer/Generator.
Perform various welding joint operations	Edge preparation Hold the Electrode at suitable angle. Identify the suitable method of Welding Techniques. Maintain proper distance between work piece and electrode tip produce arc Check weld Bead.
Perform spot welding operations	Resistance welding is done for two overlapping work pieces.

PHYSICS LABORATORY

Subject Title	:	Physics Laboratory
Subject Code	:	Common -109
Periods per week	:	03
Total periods per year	:	90

TIME SCHEDULE

S.No	Name of the Experiment	No. of Periods
1.	Hands on practice on Vernier Calipers	06
2.	Hands on practice on Screw gauge	06
3.	Verification of Parallelogram law of forces and Triangle law of forces	06
4.	Simple pendulum	06
5.	Velocity of sound in air – (Resonance method)	06
6.	Focal length and Focal power of convex lens (Separate & Combination)	06
7.	Refractive index of solid using traveling microscope	06
8.	Surface tension of liquid using traveling microscope	06
9.	Coefficient of viscosity by capillary method	06
10.	Boyle's law verification	06
11.	Meter bridge	06
12.	Mapping of magnet lines of force	06
	Revision	12
	Test	06
	Total:	90

Objectives:

Upon completion of the course the student shall be able to

- 1.0 Practise with Vernier calipers to determine the volumes and areas of a cylinder and sphere and their comparison etc .
- 2.0 Practise with Screw gauge to determine thickness of a glass plate, cross sectional area of a wire and volumes of sphere and also their comparison etc
- 3.0 Verify the parallelogram law and Triangle law
- 4.0 Determine the value of acceleration due to gravity using Simple Pendulum
- 5.0 Determine the velocity of sound in air at room temperature and its value at zero degree centigrade
- 6.0 Calculate the Focal length and focal power of convex lenses using distant object method , U-V method , U-V graph and $1/U - 1/V$ graph methods and their comparison,
- 7.0 Determine the refractive index of a solid using travelling microscope
- 8.0 Determine the surface tension of a liquid using travelling microscope

- 9.0 Determine the viscosity of a liquid using capillary method
 10.0 Verify the Boyle's law employing a Quill tube
 11.0 Determine the specific resistance of material of a wire using Meter Bridge
 12.0 Drawing magnetic lines of force under N-S and N-N methods and locate null points

Competencies and Key competencies to be achieved by the student

Name of the Experiment (No of Periods)	Competencies	Key competencies
1. Hands on practice on Vernier Calipers(03)	<ul style="list-style-type: none"> • Find the Least count • Fix the specimen in posit • Read the scales • Calculate the physical quantities of given object 	<ul style="list-style-type: none"> • Read the scales • Calculate the requisite physical quantities of given objects
2. Hands on practice on Screw gauge(03)	<ul style="list-style-type: none"> • Find the Least count • Fix the specimen in posit • Read the scales • Calculate thickness of glass plate and cross section of wire and other quantities 	<ul style="list-style-type: none"> • Read the scales • Calculate thickness of given glass plate • Calculate cross section of wire and other quantities
3. Verification of Parallelogram law of forces and Triangle law of forces(03)	<ul style="list-style-type: none"> • Fix suitable weights • Note the positions of threads on drawing sheet • Find the angle at equilibrium point • Construct parallelogram • Compare the measured diagonal • Construct triangle • Find the length of sides • Compare the ratios 	<ul style="list-style-type: none"> • Find the angle at equilibrium point • Constructing parallelogram • Construct triangle • Compare the ratios of force and length
4. Simple pendulum(03)	<ul style="list-style-type: none"> • Fix the simple pendulum to the stand • Adjust the length of pendulum • Find the time for number of oscillations • Find the time period • Calculate the acceleration due to gravity • Draw I-T and I-T² graph 	<ul style="list-style-type: none"> • Find the time for number of oscillations • Find the time period • Calculate the acceleration due to gravity • Draw I-T and I-T² graph

Name of the Experiment(Periods)	Competencies	Key competencies
5. Velocity of sound in air –Resonance method (03)	<ul style="list-style-type: none"> • Arrange the resonance apparatus • Adjust the reservoir level for booming sound • Find the first and second resonating lengths • Calculate velocity of sound 	<ul style="list-style-type: none"> • Adjust the reservoir level • Find the first and second resonating lengths • Calculate velocity of sound at room temperature • Calculate velocity of sound at 0° C
6. Focal length and Focal power of convex lens (Separate & Combination) (03)	<ul style="list-style-type: none"> • Fix the object distance • Find the Image distance • Calculate the focal length and power of convex lens and combination of convex lenses • Draw u-v and 1/u – 1/v graphs 	<ul style="list-style-type: none"> • Calculate the focal length and power of convex lens • Draw u-v and 1/u – 1/v graphs
7. Refractive index of solid using traveling microscope(03)	<ul style="list-style-type: none"> • Find the least count of vernier on microscope • Place the graph paper below microscope • Read the scale • Calculate the refractive index of glass slab 	<ul style="list-style-type: none"> • Read the scale • Calculate the refractive index of glass slab
8. Surface tension of liquid using traveling microscope(03)	<ul style="list-style-type: none"> • Find the least count of vernier on microscope • Focus the microscope to the lower meniscus & bent pin • Read the scale • Calculate height of liquid rise • Calculate the surface tension of water 	<ul style="list-style-type: none"> • Read the scale • Calculate height of liquid rise • Calculate the surface tension of water

Name of the Experiment	Competencies	Key competencies
9. Coefficient of viscosity by capillary method(03)	<ul style="list-style-type: none"> • Find the least count of vernier • Fix the capillary tube to aspiratory bottle • Find the mass of collected water • Find the pressure head • Calculate rate of volume of liquid collected • Find the radius of capillary tube • Calculate the viscosity of water using capillary 	<ul style="list-style-type: none"> • Find the pressure head • Calculate rate of volume of liquid collected • Find the radius of capillary tube • Calculate the viscosity of water
10. Boyle's law verification (03)	<ul style="list-style-type: none"> • Note the atmospheric pressure • Fix the quill tube to retort stand • Find the length of air column • Find the pressure of enclosed air • Find and compare the calculated value $P \times l$ 	<ul style="list-style-type: none"> • Find the length of air column • Find the pressure of enclosed air • Find the value $P \times l$
11. Meter bridge(03)	<ul style="list-style-type: none"> • Make the circuit connections • Find the balancing length • Calculate unknown resistance • Find the radius of wire • Calculate the specific resistance 	<ul style="list-style-type: none"> • Find the balancing length • Calculate unknown resistance • Calculate the specific resistance
12. Mapping of magnet lines of force(03)	<ul style="list-style-type: none"> • Draw magnetic meridian • Placed the bar magnet in NN and NS directions • Draw magnetic lines of force • Locate the neutral points along equatorial and axial lines 	<ul style="list-style-type: none"> • Draw magnetic lines of force • Locate the neutral points along equatorial and axial lines

CHEMISTRY LABORATORY

Subject Title	:	Chemistry Laboratory
Subject Code	:	Common -110
Periods per week	:	03
Total periods per year	:	90

TIME SCHEDULE

S.No	Name of the Experiment	No. of Periods
1.	Familiarization of methods for Volumetric analysis	06
2.	Preparation of Std Na_2CO_3 and making solutions of different dilution solution.	06
3.	Estimation of HCl solution using Std. Na_2CO_3 solution	06
4.	Estimation of NaOH using Std. HCl solution	06
5.	Estimation of H_2SO_4 using Std. NaOH solution	06
6.	Estimation of Mohr's Salt using Std. KMnO_4	06
7.	Determination of acidity of water sample	06
8.	Determination of alkalinity of water sample	06
9.	Determination of total hardness of water using Std. EDTA solution	06
10.	Estimation of Chlorides present in water sample	06
11.	Estimation of Dissolved Oxygen (D.O) in water sample	06
12.	Determination of pH using pH meter	06
13.	Determination of conductivity of water and adjusting ionic strength required	06
14.	Determination of turbidity of water	06
15.	Estimation of total solids present in water sample	06
	Total:	90

Objectives:

Upon completion of the course the student shall be able to

- 1.0 Practice volumetric measurements (using pipettes, measuring jars, volumetric flask, burettes) and gravimetric measurements (using different types of balances), making dilutions, etc.
- 2.0 Practice making standard solutions with pre weighed salts and to make solutions of desired dilutions using appropriate techniques.
- 3.0 Conduct titrations adopting standard procedures and using Std. Na_2CO_3 solution for estimation of HCl
- 4.0 Conduct titrations adopting standard procedures and using Std. HCl solution for estimation of NaOH
- 5.0 Conduct titrations adopting standard procedures and using Std. NaOH solution for estimation of H_2SO_4

- 6.0 Conduct titrations adopting standard procedures and using Std. KMnO_4 solution for estimation of Mohr's Salt
- 7.0 Conduct titrations adopting standard procedures to determine the acidity of given samples of water (One ground water and one surface / tap water, and rain water if available)
- 8.0 Conduct titrations adopting standard procedures to determine the alkalinity of given samples of water (One ground water and one surface / tap water)
- 9.0 Conduct titrations adopting standard procedures to determine the total hardness of given samples of water (One ground water and one surface / tap water) using Std. EDTA solution
- 10.0 Conduct titrations adopting standard procedures to determine the chlorides present in the given samples of water and wastewater (One ground water and one surface / tap water)
- 11.0 Conduct the test using titrometric / electrometric method to determine Dissolved Oxygen (D.O) in given water samples (One sample from closed container and one from open container / tap water)
- 12.0 Conduct the test on given samples of water / solutions (like soft drinks, sewage, etc.) to determine their pH using standard pH meter
- 13.0 Conduct the test on given samples of water / solutions
- To determine conductivity
 - To adjust the ionic strength of the sample to the desired value
- 14.0 Conduct the test on given samples of solutions (coloured and non coloured) to determine their turbidity in NTU
- 15.0 Conduct titrations adopting standard procedures to determine the total solids present in given samples of water (One ground water and one surface / tap water)

Competencies and Key competencies to be achieved by the student

Name of the Experiment (No of Periods)	Competencies	Key competencies
Familiarization of methods for Volumetric analysis (03)	--	--
Preparation of Std Na_2CO_3 and making solutions of different dilution (03)	<ul style="list-style-type: none"> ▪ Weighing the salt to the accuracy of .01 mg ▪ Measuring the water with volumetric flask, measuring jar, volumetric pipette and graduated pipette ▪ Making appropriate dilutions 	<ul style="list-style-type: none"> ▪ Weighing the salt to the accuracy of .01 mg ▪ Measuring the water with volumetric flask, measuring jar, volumetric pipette and graduated pipette ▪ Making appropriate dilutions
Name of the Experiment (No of Periods)	Competencies	Key competencies

Estimation of HCl solution using Std. Na_2CO_3 solution (03)	<ul style="list-style-type: none"> ▪ Cleaning the glassware and rinsing with appropriate solutions ▪ Making standard solutions ▪ Measuring accurately the standard solutions and titrants ▪ Filling the burette with titrant ▪ Fixing the burette to the stand ▪ Effectively Controlling the flow of the titrant ▪ Identifying the end point ▪ Making accurate observations ▪ Calculating the results 	<ul style="list-style-type: none"> ▪ Making standard solutions ▪ Measuring accurately the standard solutions and titrants ▪ Effectively Controlling the flow of the titrant ▪ Identifying the end point ▪ Making accurate observations
Estimation of NaOH using Std. HCl solution (03)		
Estimation of H_2SO_4 using Std. NaOH solution (03)		
Estimation of Mohr's Salt using Std. KMnO_4 (03)		
Determination of acidity of water sample (03)		
Determination of alkalinity of water sample (03)		
Determination of total hardness of water using Std. EDTA solution (03)		
Estimation of Chlorides present in water sample (03)		
Estimation of Dissolved Oxygen (D.O) in water sample (By titration method) (03)		
Estimation of Dissolved Oxygen (D.O) in water sample (By electrometric method) (03)	<ul style="list-style-type: none"> ▪ Familiarize with instrument ▪ Choose appropriate 'Mode' / 'Unit' ▪ Prepare standard solutions / buffers, etc. ▪ Standardize the instrument with appropriate standard solutions ▪ Plot the standard curve ▪ Make measurements accurately ▪ Follow Safety precautions 	<ul style="list-style-type: none"> ▪ Prepare standard solutions / buffers, etc. ▪ Standardize the instrument with appropriate standard solutions ▪ Plot the standard curve ▪ Make measurements accurately
Determination of pH using pH meter (03)		
Determination of conductivity of water and adjusting ionic strength to required level (03)		
Determination of turbidity of water (03)		
Name of the Experiment (No of Periods)	Competencies	Key competencies

Estimation of total solids present in water sample (03)	<ul style="list-style-type: none">▪ Measuring the accurate volume and weight of sample▪ Filtering and air drying without losing any filtrate▪ Accurately weighing the filter paper, crucible and filtrate▪ Drying the crucible in an oven	<ul style="list-style-type: none">▪ Measuring the accurate volume and weight of sample▪ Filtering and air drying without losing any filtrate▪ Accurately weighing the filter paper, crucible and filtrate
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COMPUTER FUNDAMENTALS LABORATORY
(Common to all Branches)

Subject Title : Computer Fundamentals Laboratory
Subject Code : MET-111
Periods/Week : 03
Periods/Year : 90

Time Schedule

S. No.	Major Topics	No. of sessions each of 3 periods duration	No. of Periods
I.	Computer hardware Basics	02	06
II.	Windows Operating System	02	06
III.	MS Word	08	24
IV.	MS Excel	09	27
V.	MS PowerPoint	09	27
Total		30	90

Rationale: The knowledge of Computer usage has become a must for everyone, due to wide spread computer usage and related applications in all fields. This laboratory is designed to give the students hands on practice of Windows Operating System and MS Office to enable the students to use these skills in future courses.

I. Computer Hardware Basics (Not for end examination)

1. a) To familiarize with a Computer System and its hardware connections.
b) To start and Shutdown a Computer correctly.
c) To check the software details of the computer
d) To practice Internal and External DOS commands
2. To check the hardware present in your computer.

II. Windows's operating system (Not for end examination)

3. To explore Windows Desktop
4. Working with Files and Folders
5. Windows Accessories: Calculator – Notepad – WordPad – MS Paint

III. Practice with MS-WORD

6. To familiarize with Ribbon layout of MS Word
Home - Insert - Page layout – References – Review - View
7. To practice Word Processing Basics
8. To practice Formatting techniques

9. To insert a table of required number of rows and columns
10. To insert Objects, Clipart and Hyperlinks
11. To use Mail Merge feature of MS Word
12. To use Equations and symbols features

IV. Practice with MS-EXCEL

13. To familiarize with MS-EXCEL layout
14. To access and Enter data in the cells
15. To edit a spread sheet- Copy, Cut, Paste, and selecting Cells
16. To use built in functions and Formatting Data
17. To create Excel Functions, Filling Cells
18. To enter a Formula for automatic calculations
19. To practice Excel Graphs and Charts
20. To format a Worksheet in Excel, Page Setup and Print

V. Practice with MS-POWERPOINT

21. To familiarize with Ribbon layout features of PowerPoint 2007.
22. To create a simple PowerPoint Presentation
23. To set up a Master Slide in PowerPoint
24. To insert Text and Objects
25. To insert a Flow Charts
26. To insert a Table
27. To insert a Charts/Graphs
28. To insert video and audio
29. To practice Animating text and objects
30. To Review presentation

Competencies and Key Competencies to be achieved by the students

Exp No.	Name of the Experiment	Competencies	Key Competencies
1 (a).	To familiarize with Computer system and hardware connections	<ul style="list-style-type: none"> a. Identify the Parts of a Computer system a). CPU b) Monitor c) CD/DVD Drive d) Power Switch e) Start Button f) Reset Button b. Identify and connect various peripherals c. Identify and connect the cables used with computer system d. Identify various ports on CPU and connect Keyboard & Mouse 	Connect cables to external hardware and operate the computer
1 (b).	To Start and Shut down Computer correctly	<ul style="list-style-type: none"> a. Log in using the password b. Start and shut down the computer c. Use Mouse and Keyboard 	<ul style="list-style-type: none"> a. Login and logout as per the standard procedure b. Operate mouse & Keyboard
1 (c).	To explore Windows Desktop	<ul style="list-style-type: none"> a. Familiarize with Start Menu, Taskbar, Icons and Shortcuts b. Access application programs using Start menu, Task manager c. Use Help support 	<ul style="list-style-type: none"> a. Access application programs using Start menu b. Use taskbar and Task manager
1(d).	To practice Internal and External DOS commands	<ul style="list-style-type: none"> a. Practice Internal commands b. Practice External commands 	Familiarize with MS-DOS Commands
2.	To check the software details of the computer	<ul style="list-style-type: none"> c. Find the details of Operating System being used d. Find the details of Service Pack installed 	Access the properties of computer and find the details
3.	To check the hardware present in your computer	<ul style="list-style-type: none"> a. Find the CPU name and clock speed b. Find the details of RAM and Hard disk present c. Access Device manager using Control Panel and check the status of devices like mouse and key board d. Use My Computer to check the details of Hard Disk Drives and partitions e. Use the Taskbar 	<ul style="list-style-type: none"> a. Access device manager and find the details b. Type /Navigate the correct path and Select icon related to the details required
4.	Working with Files and Folders	<ul style="list-style-type: none"> a. Create folders and organizing files in different folders b. Use copy / paste or move commands to organize files and folders 	a. Create files and folders rename , arrange and search for the required folder/file

Exp No.	Name of the Experiment	Competencies	Key Competencies
	Working with Files and Folders Continued....	<ul style="list-style-type: none"> c. Arrange icons – name wise, size, type, Modified d. Search a file or folder and find its path e. Create shortcut for files and folders (in other folders) on Desktop f. Familiarize with the use of My Documents g. Familiarize with the use of Recycle Bin 	<ul style="list-style-type: none"> b. Restore deleted files from Recycle bin
5.	To use Windows Accessories: Calculator – Notepad – WordPad – MS Paint	<ul style="list-style-type: none"> a. Familiarize with the use of Calculator b. Access Calculator using Run command c. Create Text Files using Notepad and WordPad and observe the difference in file size d. Use MS paint and create .jpeg, .bmp files using MS Paint 	<ul style="list-style-type: none"> a. Use windows accessories and select correct text editor based on the situation. b. Use MS Paint to create /Edit pictures and save in the required format.
6.	To familiarize with Ribbon layout of MS Word. – Home – Insert- Page Layout- References-Review-View	<ul style="list-style-type: none"> a. Create/Open a document b. Use Save and Save as features c. Work on two documents simultaneously d. Choose correct Paper size and Printing options 	<ul style="list-style-type: none"> a. Create a Document and name appropriately and save b. Set paper size and print options
7.	To practice Word Processing Basics	<ul style="list-style-type: none"> a. Typing text b. Keyboard usage c. Use mouse (Left click / Right click / Scroll) d. Use Keyboard shortcuts e. Use Find and Replace features in MS- word f. Use Undo and Redo Features g. Use spell check to correct Spellings and Grammar 	<ul style="list-style-type: none"> a. Use keyboard and mouse to enter/edit text in the document. b. Use shortcuts c. Use spell check/ Grammar features for auto corrections.
8.	To practice Formatting techniques	<ul style="list-style-type: none"> a. Formatting Text b. Formatting Paragraphs c. Setting Tabs d. Formatting Pages e. The Styles of Word f. Insert bullets and numbers g. Themes and Templates h. Insert page numbers, header and footer 	<ul style="list-style-type: none"> a. Format Text and paragraphs and use various text styles. b. Use bullets and numbers to create lists c. Use Templates /Themes d. Insert page numbers date, headers and footers

Exp No.	Name of the Experiment	Competencies	Key Competencies
9.	To insert a table of required number of rows and columns	<ul style="list-style-type: none"> a. Edit the table by adding the fields – Deleting rows and columns – inserting sub table –marking borders. Merging and splitting of cells in a Table b. Changing the background colour of the table c. Use table design tools d. Use auto fit – fixed row/ column height/length – Even distribution of rows / columns features e. Convert Text to table and Table to Text f. Use Sort feature of the Table to arrange data in ascending/descending order 	<ul style="list-style-type: none"> a. Insert table in the word document and edit b. Use sort option for arranging data.
10.	To Insert objects, clipart and Hyperlinks	<ul style="list-style-type: none"> a. Create a 2-page document. &Insert hyperlinks and Bookmarks. b. Create an organization chart c. Practice examples like preparing an Examination schedule notice with a hyperlink to Exam schedule table. 	<ul style="list-style-type: none"> a. Insert hyperlinks &Bookmarks b. Create organization charts/flow charts
11.	To Use Mail merge feature of MS Word	<ul style="list-style-type: none"> a. Use mail merge to prepare individually addressed letters b. Use mail merge to print envelopes. 	Use Mail merge feature
12.	To use Equations and symbols features.	<ul style="list-style-type: none"> a. Explore various symbols available in MS Word b. Insert a symbol in the text c. Insert mathematical equations in the document 	Enter Mathematical symbols and Equations in the word document
13.	To Practice with MS-EXCEL	<ul style="list-style-type: none"> a. Open /create an MS Excel spreadsheet and familiarize with MS Excel 2007 layout like MS office Button- b. Use Quick Access Toolbar- Title Bar- Ribbon-Worksheets- Formula Bar- Status Bar 	<ul style="list-style-type: none"> a. Familiarize with excel layout and use b. Use various features available in toolbar
14.	To access and Enter data in the cells	<ul style="list-style-type: none"> a. Move around a Worksheet- Quick access -Select Cells b. Enter Data-Edit a Cell-Wrap Text- Delete a Cell Entry-Save a File-Close Excel 	<ul style="list-style-type: none"> a. Access and select the required cells by various addressing methods b. Enter data and edit

Exp No.	Name of the Experiment	Competencies	Key Competencies
15.	To edit spread sheet Copy, Cut, Paste, and selecting cells	<ul style="list-style-type: none"> a. Insert and Delete Columns and Rows-Create Borders-Merge and Center b. Add Background Color-Change the Font, Font Size, and Font Color c. Format text with Bold, Italicize, and Underline-Work with Long Text-Change a Column's Width 	Format the excel sheet
16.	To use built in functions and Formatting Data	<ul style="list-style-type: none"> a. Sort and filter data in a worksheet b. Perform Mathematical Calculations verify -AutoSum c. Perform Automatic Calculations-Align Cell Entries 	Use built in functions in Excel
17.	To enter a Formula for automatic calculations	<ul style="list-style-type: none"> a. Enter formula b. Use Cell References in Formulae c. Use Automatic updating function of Excel Formulae d. Use Mathematical Operators in Formulae e. Use Excel Error Message and Help 	Enter formula for automatic calculations
18.	To Create Excel Functions, Filling Cells	<ul style="list-style-type: none"> a. Use Reference Operators b. Work with sum, Sum if , Count and Count If Functions c. Fill Cells Automatically 	<ul style="list-style-type: none"> a. Create Excel sheets involving cross references and equations b. Use the advanced functions for conditional calculations
19.	To Practice Excel Graphs and Charts	<ul style="list-style-type: none"> a. Produce an Excel Pie Chart b. Produce an Excel Column Chart c. Practice creating any Chart 	<ul style="list-style-type: none"> a. Use data in Excel sheet to Create technical charts and graphs Produce Excel Line Graph b. Produce a Pictograph in Excel
20.	To format a Worksheet in Excel, page setup and print	<ul style="list-style-type: none"> a. Shade alternate rows of data b. Add currency and percent symbols c. Change height of a row and width of a column d. Change data alignment e. Insert Headers and Footers f. Set Print Options and Print 	<ul style="list-style-type: none"> a. Format Excel sheet b. Insert headers & footers and print
21.	To familiarize with Ribbon layout & features of PowerPoint 2007.	Use various options in Home, insert, design, animation , slideshow, Review & View in the PowerPoint	Access required options in the tool bar

Exp No.	Name of the Experiment	Competencies	Key Competencies
22.	To create a simple PowerPoint Presentation	<ul style="list-style-type: none"> a. Insert a New Slide into PowerPoint b. Change the Title of a PowerPoint Slide c. PowerPoint Bullets d. Add an Image to a PowerPoint Slide e. Add a Textbox to a PowerPoint slide 	<ul style="list-style-type: none"> a. Create simple PowerPoint presentation with photographs/ClipArt and text boxes b. Use bullets option
23.	To Set up a Master Slide in PowerPoint and add notes	<ul style="list-style-type: none"> a. Create a PowerPoint Design Template b. Modify themes c. Switch between Slide master view and Normal view d. Format a Design Template Master Slide e. Add a Title Slide to a Design Template f. The Slide Show Footer in PowerPoint f. Add Notes to a PowerPoint Presentation 	<ul style="list-style-type: none"> a. Setup Masterslide and format b. Add notes
24.	To Insert Text and Objects	<ul style="list-style-type: none"> a. Insert Text and objects b. Set Indents and line spacing c. Insert pictures/ clipart d. Format pictures e. Insert shapes and WordArt f. Use 3d features g. Arrange objects 	<ul style="list-style-type: none"> Inset Text and Objects Use 3d features
25.	To insert a Flow Chart / Organizational Charts	<ul style="list-style-type: none"> a. Create a Flow Chart in PowerPoint b. Group and Ungroup Shapes c. Use smart art 	<ul style="list-style-type: none"> Create organizational charts and flow charts using smart art
26.	To insert a Table	<ul style="list-style-type: none"> a. PowerPoint Tables b. Format the Table Data c. Change Table Background d. Format Series Legend 	<ul style="list-style-type: none"> Insert tables and format
27.	To insert a Charts/Graphs	<ul style="list-style-type: none"> a. Create 3D Bar Graphs in PowerPoint b. Work with the PowerPoint Datasheet c. Format a PowerPoint Chart Axis d. Format the Bars of a Chart e. Create PowerPoint Pie Charts f. Use Pie Chart Segments g. Create 2D Bar Charts in PowerPoint h. Format the 2D Chart e. Format a Chart Background 	<ul style="list-style-type: none"> Create charts and Bar graphs, Pie Charts and format.

Exp No.	Name of the Experiment	Competencies	Key Competencies
28.	To Insert audio & video, Hyperlinks in a slide Add narration to the slide	<ul style="list-style-type: none"> a. Insert sounds in the slide and hide the audio symbol b. Adjust the volume in the settings c. Insert video file in the format supported by PowerPoint in a slide d. Use automatic and on click options e. Add narration to the slide f. Insert Hyperlinks 	<ul style="list-style-type: none"> a. Insert Sounds and Video in appropriate format. b. Add narration to the slide c. Use hyperlinks to switch to different slides and files
29.	To Practice Animation effects	<ul style="list-style-type: none"> a. Apply transitions to slides b. To explore and practice special animation effects like <i>Entrance, Emphasis, Motion Paths & Exit</i> 	Add animation effects
30.	Reviewing presentation	<ul style="list-style-type: none"> a. Checking spelling and grammar b. Previewing presentation c. Set up slide show d. Set up resolution e. Exercise with Rehearse Timings feature in PowerPoint f. Use PowerPoint Pen Tool during slide show g. Saving h. Printing presentation <ul style="list-style-type: none"> (a) Slides (b) Handout 	<ul style="list-style-type: none"> a. Use Spell check and Grammar feature b. Setup slide show c. Add timing to the slides d. Setup automatic slide show

**III-SEM
(C-16)**

ENGINEERING MATHEMATICS – II**(Common to all Branches)**

Subject Title	:	Engineering Mathematics-II
Subject Code	:	MET-301
Periods per week	:	05
Periods per Semester	:	75

Blue print

S. No	Major Topic	No of Periods	Weightage of Marks	Short Type			Essay Type		
				R	U	App	R	U	App
	Unit - I								
1	Indefinite Integration	15	21	1	1	0	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
	Unit - II								
2	Definite Integration and its applications	35	60	1	1	3	1	1	$2\frac{1}{2}$
	Unit - III								
3	Differential Equations	25	29	2	1	0	1	1	0
	Total	75	110	4	3	3	$2\frac{1}{2}$	$2\frac{1}{2}$	30
			Marks:	12	9	9	25	25	30

R: Remembering type 37 marks**U: Understanding type** 34 marks**App: Application type** 39 marks**OBJECTIVES**

Upon completion of the subject the student shall be able to

Unit-I**1.0 Indefinite Integration**

1.1 Explain the concept of Indefinite integral as an anti-derivative.

- 1.2 State the indefinite integral of standard functions and properties of Integrals $\int (u + v) dx$ and $\int ku dx$ where k is constant and u, v are functions of x .
- 1.3 Solve integration problems involving standard functions using the above rules.
- 1.4 Evaluate integrals involving simple functions of the following type by the method of substitution.
- $\int f(ax + b) dx$ where $f(x) dx$ is in standard form.
 - $\int [f(x)]^n f'(x) dx$
 - $\int f'(x)/[f(x)] dx$
 - $\int f\{g(x)\} g'(x) dx$
- 1.5 Find the Integrals of $\tan x, \cot x, \sec x$ and $\operatorname{cosec} x$ using the above.
- 1.6 Evaluate the integrals of the form $\int \sin^m \theta \cos^n \theta. d\theta$ where m and n are positive integers.
- 1.7 Evaluate integrals of powers of $\tan x$ and $\sec x$.
- 1.8 Evaluate the Standard Integrals of the functions of the type

$$i) \frac{1}{a^2 + x^2}, \frac{1}{a^2 - x^2}, \frac{1}{x^2 - a^2}$$

$$ii) \frac{1}{\sqrt{a^2 + x^2}}, \frac{1}{\sqrt{a^2 - x^2}}, \frac{1}{\sqrt{x^2 - a^2}}$$

$$iii) \sqrt{x^2 - a^2}, \sqrt{x^2 + a^2}, \sqrt{a^2 - x^2}$$

- 1.9 Evaluate the integrals of the type

$$\int \frac{1}{a \pm b \sin \theta} d\theta, \int \frac{1}{a \pm b \cos \theta} d\theta \text{ and } \int \frac{1}{a \cos \theta \pm b \sin \theta \pm c} d\theta .$$

- 1.10 Evaluate integrals using decomposition method.
- 1.11 Evaluate integrals using integration by parts with examples.
- 1.12 State the Bernoulli's rule for evaluating the integrals of the form $\int u.v dx$.
- 1.13 Evaluate the integrals of the form $\int e^x [f(x) + f'(x)] dx$.

Unit-II

(a) Understand definite integral and its properties

- State the fundamental theorem of integral calculus
- Explain the concept of definite integral.
- Calculate the definite integral over an interval.
- State various properties of definite integrals.
- Evaluate simple problems on definite integrals using the above properties.

(b) Real life applications of definite integrals

- Explain definite integral as a limit of sum by considering an area.
- Find the areas under plane curves and area enclosed between two curves using integration.
- Obtain the volumes of solids of revolution.

- 2.9 Obtain the mean value and root mean square value of the functions in any given interval.
- 2.10 Explain the Trapezoidal rule, Simpson's 1/3 rules for approximation of integrals and provide some examples.

(c) Certain special integrals: Laplace Transforms

- 2.11 Write the definition of Laplace Transform and explain sufficient conditions for its existence.
- 2.12 Provide formulae for Laplace transforms of standard functions.
- 2.13 State Linear property, First shifting property, Change of Scale property for Laplace transforms. Solve simple problems using these properties.
- 2.14 Write formulae for Laplace transform of $t^n f(t)$, $\frac{f(t)}{t}$, $f^{(n)}(t)$, $\int_0^t f(u) du$ in terms of Laplace transform of $f(t)$. Provide simple examples on these functions.
- 2.15 Define unit step function and write the Laplace Transform of unit step function.
State second shifting property.
- 2.16 Define inverse Laplace Transform and write inverse Laplace Transform of standard functions. Solve simple problems.
- 2.17 Write first shifting property of inverse Laplace Transform with examples
- 2.18 Define convolution of two functions and state convolution theorem with few examples for understanding only.

(d) Understand the Fourier series expansion of functions

- 2.19 Define Fourier series of a function on the interval $(c, c + 2l)$ and state sufficient conditions for its existence. Write the Euler's formulae for determining the Fourier coefficients.
- 2.20 Find Fourier series of simple functions in the range $(0, 2l)$, $(0, 2\pi)$, $(-l, l)$ and $(-\pi, \pi)$.
- 2.21 Find Fourier coefficients for even and odd functions in the interval $(-l, l)$ and $(-\pi, \pi)$ in simple examples.
- 2.22 Define half range Fourier sine and cosine series of a function over the interval $(0, l)$ with examples.

3.0 Introduction to Differential Equations

- 3.1 Define a Differential equation, its order, degree
- 3.2 Form a differential equation by eliminating arbitrary constants.
- 3.3 Solve the first order first degree differential equations by the following methods:
- i. Variables Separable.
 - ii. Homogeneous Equations.
 - iii. Exact Differential Equations
 - iv. Linear differential equation of the form $dy/dx + Py = Q$, where P and Q are functions of x or constants.
 - iv. Bernoulli's Equation (Reducible to linear form.)
- 3.4 Solve Differential equations of the type $(aD^2 + bD + c)y = 0$ when the roots of the auxiliary equation are real and different, real and repeated, Complex conjugates.
- 3.5 Solve the higher order homogeneous differential equations with constant coefficients.
- 3.6 Explain the concept of complementary function, particular Integral and general solution of a differential equation.
- 3.7 Solve n^{th} order differential equation of the type $f(D)y = X$ where $f(D)$ is a polynomial of nth order and X is a function of the form $k, e^{ax}, \text{Sin}ax, \text{Cos}ax, x^n$.
- 3.8 Solve simple problems leading to engineering applications

COURSE CONTENT

Unit-I

Indefinite Integration:

1. Integration regarded as anti-derivative – Indefinite integral of standard functions. Properties of indefinite integral. Integration by substitution or change of variable. Integrals of the form $\sin^m \theta, \cos^n \theta$. where m and n are positive integers. Integrals of $\tan x, \cot x, \sec x, \text{cosec } x$ and powers of $\tan x, \sec x$ by substitution.

Evaluation of integrals which are reducible to the following forms :

$$i) \frac{1}{a^2 + x^2}, \frac{1}{a^2 - x^2}, \frac{1}{x^2 - a^2}$$

$$ii) \frac{1}{\sqrt{a^2 + x^2}}, \frac{1}{\sqrt{a^2 - x^2}}, \frac{1}{\sqrt{x^2 - a^2}}$$

$$iii) \sqrt{x^2 - a^2}, \sqrt{x^2 + a^2}, \sqrt{a^2 - x^2}$$

Integration by decomposition of the integrand into simple rational, algebraic functions. Integration by parts, Bernoulli's rule.

Unit-II

Definite Integral and its applications:

2. Definite integral-fundamental theorem of integral calculus, properties of definite integrals, evaluation of simple definite integrals. Definite integral as the limit of a sum. Area under plane curves – Area enclosed between two curves. Volumes of solids of revolution. Mean and RMS values of a function on a given interval. Trapezoidal rule, Simpson's 1/3 rule to evaluate an approximate value of a definite integral.

Definition, sufficient conditions for existence of Laplace Transform (LT), LT of elementary functions, linearity property, scale change property, first shifting property, multiplication by t^n , division by t , LT of derivatives and integrals, unit step function, LT of unit step function, second shifting theorem, inverse Laplace transforms- shifting theorems and change of scale property, multiplication by s^n and division by s – examples of inverse LT using partial fractions – convolution theorem (no proof).

Representation of a function in Fourier series over the interval $(c, c + 2l)$, Give sufficient conditions for existence of Fourier series. Euler's formulae for Fourier coefficients, Finding Fourier coefficients for simple functions, elementary even and odd functions. Define half range Fourier series.

Unit -III

Differential Equations:

Definition of a differential equation-order and degree of a differential equation- formation of differential equations-solution of differential equation of first order, first degree: variable-separable, homogeneous, exact, linear differential equation, Bernoulli's equation.

Homogenous linear differential equations with constant coefficients of order two and higher with emphasis on second order.

Non-homogenous linear differential equations with constant coefficients of the form $f(D)y = X$, where X is in the form $k, e^{ax}, \sin ax, \cos ax, x^n$, ($n= 1,2$) – complimentary function, particular integral and general solution.

Reference Books:

1. Integral Calculus Vol.I, by M.Pillai and Shanti Narayan
2. Thomas' Calculus, Pearson Addison –Wesley Publishers
3. A Text book of Engg. Mathematics by B.S.Grawel
4. A Text book of Engg. Mathematics by B.V.Ramana- T.Mc Graw Hill Publishers

ELECTRICAL TECHNOLOGY

Subject Title : **Electrical Technology**
Subject Code : **Met-302**
Periods per Week : **04**
Periods / Semester : **60**

TIME SCHEDULE

S No	Major Topics	Periods	Weightage of Marks	Short Type	Essay Type
1.	D.C. Series – Parallel circuits	4	3	2	-
2.	Electro Magnetism and Electromagnetic Induction	6	13	1	1
3.	D.C. Generators	5	13	1	1
4.	D.C. Motors	6	10	-	1
5.	Single phase and 3 phase Circuits	10	16	2	1
6.	Single phase Transformers	10	16	1	1
7.	Electric heating and Welding	9	13	1	1
8.	Electrical measuring instruments	5	13	1	1
9.	Semiconductor Diode and Transistor	5	13	1	1
	TOTAL	60	110	10	8

OBJECTIVES

Upon study the students is able to understand

- 1.0** Solve D.C. Series –parallel circuits
 - 1.1 Calculate equivalent resistance of series and parallel circuits.
 - 1.2 To solve problems on series parallel circuits
 - 1.3 State and explain Kirchhoff's laws
- 2.0 Understand principles of Electro-Magnetism and electromagnetic Induction**
 - 2.1 Explain the terms – permeability, Field strength, Flux and Flux Density.
 - 2.2 State cork screw rule
 - 2.3 Express field strength due to straight current carrying conductor (No derivation)
 - 2.4 Express Field strength on the axis of a solenoid (No derivation)
 - 2.5 State Faraday's Laws of Electro – Magnetic Induction
 - 2.6 State Lenz's Law
 - 2.7 Distinguish between self induced e.m.f and mutually induced e.m.f
 - 2.8 State expression for self-inductance and mutual inductance (No derivation).
- 3.0 Understand working of D.C. Generators**
 - 3.1 Explain working principle of D.C. generators
 - 3.2 List the parts of D.C. generators and materials used for different parts.
 - 3.3 State functions of each part of D.C. generator.
 - 3.4 State E.M.F equation

- 3.5 Solve problems on E.M. F. equation.
- 3.6 Classify D.C. Generators as shunt, series and compound generators and indicate direction of currents.
- 3.7 Simple problems on the above.
- 3.8 Applications of DC Generators.
- 4.0 Understand working of D.C. Motors**
- 4.1 Explain principle of working of D.C. motor
- 4.2 Classify D.C. motors as shunt, series and compound motors and indicate directions of currents.
- 4.3 State back E.M.F. (no derivation)
- 4.4 Write formula for speed of D.C. motor in terms of supply voltage current and flux.
- 4.5 State Torque equation (no derivation).
- 4.6 Explain necessity of starter.
- 4.7 Describe 3-point starter with diagram of connections.
- 4.8 Explain speed control of D.C. shunt motor by
 (1) Armature control
 (2) Field control
 with necessary circuit diagram and characteristics.
- 4.9 State applications of DC Motors.
- 5.0 Understand single and 3 phase systems**
- 5.1 Define : waveform, cycle, time, period, frequency, instantaneous value, maximum value, average value and R.M.S. value.
- 5.2 State expression for average and R.M.S. values in terms of maximum value.
- 5.3 Explain instantaneous value in terms of maximum value.
- 5.4 Explain phase and phase difference (with graph only), Define the term power factor.
- 5.5 State equation for power in single-phase circuits.
- 5.6 State active power ,reactive power and apparent power.
- 5.7 State phase and line voltage and currents and their relationships in three phase star and in delta connections.
- 5.8 State expression for power in 3-phase circuit.
- 5.9 Simple problems on star and delta connected loads.
- 6.0 Know working of single and Transformer**
- 6.1 Explain construction details of single phase transformer.
- 6.2 Explain working principle of single phase transformer.
- 6.3 Classify transformers basing on types of cores (core, sheel and berry type)
- 6.4 State step up and step down transformers.
- 6.5 Various losses in Transformers
- 6.6 Define the terms Efficiency and regulation of transformer.
- 7.0 Understand principles of Electric Heating and welding**
- 7.1 Classification of different electric heating methods
- 7.2 Classification of different electric welding methods
- 7.3 Explain DC welding generator with sketch.
- 7.4 Describe welding transformer with sketch.
- 7.5 State safety precautions to be adopted for prevention of electric shock to persons working on electric equipments or live wires.
- 8.0 Understand the use of electrical measuring instruments**
- 8.1 State the use of M.C. & M.I. ammeter and voltmeter.
- 8.2 State use of Megger, Multimeter and Energy meter in electrical measurements.
- 8.3 Explain the thermocouple measurements and their calibration.

9.0 Understand electronic devices.

- 9.1 Understand the use of semi conductor diode and Transistor.
- 9.2 Classify materials as conductors, semi conductors and Insulators.
- 9.3 Distinguish between Intrinsic and extrinsic semiconductors.
- 9.4 Describe the formation of a P type and N type materials
- 9.5 Identify majority and minority carries in P & N type materials
- 9.6 Explain the formation of PN junction diode
- 9.7 Explain diode as rectifier

COURSE CONTENTS

- 1. Solutions of D.C. series, parallel circuits, Kirchoff's laws.
- 2. Electro Magnetism, electro magnetic induction, self and Mutual inductances
- 3. D.C. generators, working construction, types of generators E.M.F. equation
- 4. D.C. motors- working, types of motors, applications, back E.M.F, torque equation, 3point starter, speed control
- 5. Single phase circuits, generation of E.M.F. wave form values of A.C., phase and phase difference, power factor, equation for power, different expressions for apparent and reactive power. Generation of 3 phases E.M. F., star and delta connected system and loads.
- 6. Single phase Transformers construction and working principle ,losses in transformers, definition of efficiency and regulation of transformers.
- 7. Electric heating and Electric welding classification.
- 8. Electrical measuring Instruments, ammeter, voltmeter, megger, multi meter and energy meter (single phase), thermocouple measurement and calibration.
- 9. Semi conductor – n-type – p-type Behavior of p-n junction diode. Introduction of rectifiers

Reference Books

- 1. Electrical Technology by B.L. Theraja
- 2. Utilization of Electrical Power by Taylor.
- 3. The Art & Science of Utilization of Electrical Energy by H. Partap.
- 4. Electrical Technology by Huges
- 5. Electrical technology by V.K. Mehta.
- 6. Electrical Engineering by M.S.Naidu& S.Kamakshiah

FUELS, REFRACTORIES AND PYROMETRY

Subject Title : Fuels, Refractories and Pyrometry
Subject Code : 303
Periods per week : 5
Periods per semester : 75

TIME SCHEDULE

S.NO.	MAJOR TOPICS	PERIODS	WEIGHTAGE OF MARKS	SHORT TYPE	ESSAY TYPE
1	Important Industrial fuels	11	16	2	1
2	Gasification of fuels & pulverization	12	16	2	1
3	Numerical problems on combustion	8	10	-	1
4	Non-conventional energy resources and Nuclear fuels	12	16	2	1
5	Refractories	8	13	1	1
6	Manufacture of Refractories	8	13	1	1
7	Heat transfer	8	13	1	1
8	Pyrometry	8	13	1	1
	TOTAL	75	110	10	8

OBJECTIVES

On the completion of the course the student will be able to understand

1.IMPORTANT INDUSTRIAL FUELS

- 1.1 Define the terms Fuel, Calorific value – Net and gross, combustion of fuels, carbonisation, flash and fire points, Ignition temperature, coking.
- 1.2 Classify the fuels – based on occurrence and state.
- 1.3 State the origin of fuels.
- 1.4 State the various solid, liquid and gaseous fuels and their applications .
- 1.5 Distinguish between proximate and ultimate analysis of coal.
- 1.6 Classify the coals and rank of coal .
- 1.7 List out the Merits and Demerits of solid, liquid and gaseous fuels.
- 1.8 State the carbonisation processes - L.T and H.T.
- 1.9 Distinguish between Low temp and High temp carbonisation.
- 1.10 State the characteristics of metallurgical coke.
- 1.11 Explain the manufacturing processes of metallurgical coke by beehive, retort and by product processes.
- 1.12 List out various by-products of coke oven & State their uses

2.0 GASIFICATION OF FUELS: & PULVERIZATION:

- 2.1 Define gasification
- 2.2 State the purpose of gasification.
- 2.3 Explain the manufacturing processes of producer gas, Water gas, carburetted water gas.
- 2.4 State the composition and uses of each gaseous fuel.
- 2.5 Distinguish between Producer gas and Water gas.
- 2.6 Distinguish between Water gas and Carburetted water gas.
- 2.7 State the composition and uses of B.F/c gas and Coke oven gas.
- 2.8 Define pulverisation.
- 2.9 State the necessity of pulverisation.
- 2.10 Name the methods of pulverisation.
- 2.11 List out the advantages and limitations of Pulverised fuels.

3.0 NUMERICAL PROBLEMS ON COMBUSTION:

- 3.1 Explain the General Principles of combustion.
- 3.2 Explain the Raw materials and Products of combustion.
- 3.3 Calculate the theoretical & actual air required for combustion.
- 3.4 Calculate the composition of products of combustion.
- 3.5 Convert the volume basis to weight basis and vice versa.
- 3.6 Calculate the calorific value of a fuel by Dulong's formula.

4.0 Non-conventional energy resources and Nuclear Fuels:

- 4.1 Define Non-Conventional Energy Resources.
- 4.2 State the necessity of Non conventional Energy Resources.
- 4.3 List out the non-conventional energy resources and classify them.
- 4.4 Appreciate the applications of various non-conventional energy resources in India.
- 4.5 Explain the use of solar energy as non-conventional resource.
- 4.6 List out the merits and demerits of solar energy converter
- 4.7 Applications of solar energy.
- 4.8 Introduction to wind energy.
- 4.9 applications of wind energy
- 4.10 State the importance of Nuclear Fuels.
- 4.11 List out the types of Nuclear Fuels.
- 4.12 Explain the advantages of nuclear fuels.
- 4.13 Various disadvantages of Nuclear

5.0 Refractories:

- 5.1 Define the term Refractory.
- 5.2 State the needs of refractories.
- 5.3 Classify the refractory materials.
- 5.4 List out the properties of refractory materials.
- 5.5 Explain the properties of the refractory material.
- 5.6 Explain the following tests on Refractories.
a. Porosity b. P.C.E c. R.U.L. d. Bulk Density
e. Permeability f. Cold Crushing Strength
- 5.7 Explain the causes of refractory failures and remedies

6.0 Manufacturing of refractory bricks:

- 6.1 Explain the manufacturing of Alumino-silicate refractories-Fire Clay.
- 6.2 State the properties and applications of Fire Clay Refractories.
- 6.3 Explain the manufacturing of SiO₂ refractories.
- 6.4 State the properties and applications of SiO₂.
- 6.5 State the phase transformations in Silica/Quartz.
- 6.6 Explain the manufacturing of Magnesite refractories.
- 6.7 State the properties and applications of Magnesite refractories.
- 6.8 Name the Neutral Refractories.
- 6.9 Describe the manufacturing process of carbon bricks.
- 6.10 State the properties and applications of carbon bricks.

7.0 HEAT TRANSFER:

- 7.1 State the different modes of heat transfer.
- 7.2 Define conduction.
- 7.3 State the Fourier's Law of Heat Conduction.
- 7.4 Calculate the rate of heat transfer in single and composite walls of metallurgical systems.
- 7.5 Define Radiation.
- 7.6 State the Stefan-Boltzman Law of radiation.
- 7.7 Define Black Body.
- 7.8 Define Emissivity, Absorbivity and Reflectivity.
- 7.9 State Planck and Wien's law of distribution of radiant energy

8.0 Pyrometry:

- 8.1 Define Pyrometer.
- 8.2 State the need of pyrometer
- 8.3 State the different types of pyrometers.
- 8.4 State the advantages, limitations and applications of Pyrometers.
- 8.5 Explain the working principle of Thermocouple.
- 8.6 State the advantages, limitations and applications of thermocouples
- 8.7 State the principle of resistance Pyrometers.
- 8.8 State the advantages, limitations and applications
- 8.9 Describe the working principle of Optical Pyrometers.
- 8.10 Explain the working of Radiation Pyrometer.
- 8.11 Compare Optical and Radiation Pyrometers.

COURSE CONTENTS:

1.Important industrial fuels:

Define Fuel, Calorific value – Net and gross, combustion of fuels, carbonisation, flash and fire points, Ignition temperature, coking. Classify the fuels –.State the origin of fuels. types of fuels and their applications. proximate and ultimate analysis of coal. Classify the coals and Rank of coals. Merits and Demerits of solid, liquid and gaseous fuels. L.T and H.T. Distinguish between Low temp and High temp carbonisation.State the characteristics of metallurgical coke.Explain the manufacturing processes of metallurgical coke by beehive, retort and by product processes.List out various by-products of coke oven & State their uses.

2.0 Gasification of fuels & pulverization :

Define gasification. State the purpose of gasification. Explain the manufacturing processes of producer gas, Water gas, carburetted water gas. State the composition and uses of each gaseous fuel. Distinguish between Producer gas and Water gas. Distinguish between Water gas and Carburetted water gas. State the composition and uses of B.F/c gas and Coke oven gas. Define pulverisation. State the necessity of pulverisation. Name the methods of pulverisation. List out the advantages and limitations of Pulverised fuels.

3.0 Numerical problems on combustion:

Explain the General Principles of combustion. Explain the Raw materials and Products of combustion. Calculate the theoretical & actual air required for combustion. Calculate the composition of products of combustion. Convert the volume basis to weight basis and vice versa. Calculate the calorific value of a fuel by Dulong's formula.

4.0 Non-conventional energy resources and Nuclear Fuels:

Define Non-Conventional Energy Resources. State the necessity of Non conventional Energy Resources. List the non-conventional energy resources and classify them. Appreciate the applications of various non-conventional energy resources in India. Explain the use of solar energy as non-conventional resource. List out the merits and demerits of solar energy. Applications of solar energy. Introduction to wind energy. Application of wind mills. State the importance of Nuclear Fuels. List out the types of Nuclear Fuels. List out the applications of Nuclear Fuels.

5.0 REFRACTORIES:

Define the term Refractory, State the needs of refractories, Classify the refractory materials, List out the properties of refractory materials, Explain the properties of the refractory material, Explain Porosity, P.C.E, R.U.L, Bulk Density, Permeability, Cold Crushing Strength, Explain the causes of refractory failures and remedies.

6.0 MANUFACTURING OF REFRACTORY BRICKS:

Explain the manufacturing of Alumino-silicate refractories-Fire Clay, State the properties and applications of Fire Clay Refractories, Explain the manufacturing of SiO_2 refractories, State the properties and applications of SiO_2 , State the phase transformations in Silica/Quartz, Explain the manufacturing of Magnesite refractories, State the properties and applications of Magnesite refractories, Name the Neutral Refractories Describe the manufacturing process of carbon bricks, State the properties and applications of carbon bricks.

7.0 HEAT TRANSFER:

State the different modes of heat transfer, Define conduction, State the Fourier's Law of Heat Conduction, Calculate the rate of heat transfer in single and composite walls of metallurgical systems, Define Radiation, State the Stefan-Boltzman Law of radiation, Define Black Body, Define Emissivity, Absorbivity and Reflectivity, State Planck and Wien's law of distribution of radiant energy.

8.0 PYROMETRY:

Define Pyrometer, State the need of pyrometer, State the different types of pyrometers, State the advantages, limitations and applications of Pyrometers, Explain the working principle of Thermocouple, State the advantages, limitations and applications of thermocouples, State the principle of resistance Pyrometers, State the advantages, limitations and applications, Describe the working principle of Optical Pyrometers, Explain the working of Radiation Pyrometer, Compare Optical and Radiation Pyrometers.

REFERENCE BOOKS:

1. Fuels, Furnaces and Refractories - by O.P. Gupta
2. Non-conventional fuels- by G.D.Rai
3. Fuels and combustion - by Sameer sarkar

PHYSICAL METALLURGY

Subject Title	:	Physical Metallurgy.
Subject Code	:	Met-304
Periods per Week	:	05
Periods per Semester	:	75

TIME SCHEDULE

S No	Major Topics	Periods	Weightage of Marks	Short Type	Essay Type
1	Structure of Metals and Alloys	8	13	1	1
2	Diffusion	4	3	1	-
3	Solidification of Metals and Alloys.	14	18	1	1.5
4	Binary Thermal Equilibrium Diagrams	15	26	2	2
5	Study of Iron – Carbon System	10	13	1	1
6	Study of important Non-Ferrous binary Systems	12	21	2	1.5
7	Characterization of Metals	12	16	2	1
	Total	75	110	10	8

OBJECTIVES

Upon the completion of study of the subject the student should be able to Understand

1.0 Structure of Metals and alloys.

- 1.1 Explain Metallic bond.
- 1.2 Define Space lattice & Unit Cell.
- 1.3 State different Crystal Systems and classify them into Space Lattices.
- 1.4 Define the terms:
 - a) Lattice parameter,
 - b) Co-ordination number,
 - c) Effective no. of atoms,
- 1.5 Calculate the c/a ratio for H.C.P. Structure.
- 1.6 Calculate the packing factor for
 - a) BCC
 - b) FCC
 - c) HCP

2.0 Diffusion

- 2.1 Define Diffusion.
- 2.2 State Fick's laws of Diffusion.
- 2.3 State the effect of Temperature on Diffusion with the help of a graph.
- 2.4 State the types of Diffusion Mechanisms.

3.0 Solidification of Metals & Alloys

- 3.1 Differentiate Metal & Alloy.
- 3.2 Define Phase & List the types of Solid phases.
- 3.3 Define Solid solution and classify the Solid Solutions.
- 3.4 Explain the rules governing the formation of Solid Solutions.
- 3.5 State different types of Intermediate phases and their properties.

- 3.6 Define cooling curve.
- 3.7 Draw the cooling curves for a pure metal and alloy.
- 3.8 Explain the process of crystallization with respect to
 - a) Nucleation
 - b) Growth
 - c) under cooling
- 3.9 Define dendritic growth & Coring
- 3.10 Define Homogeneous Nucleation.
- 3.11 Define Heterogeneous Nucleation.

4.0 Binary thermal Equilibrium Diagrams.

- 4.1 Define Equilibrium diagram.
- 4.2 State the applications and limitations of Equilibrium diagrams.
- 4.3 Classify the Binary Systems.
- 4.4 Define an Isomorphous system.
- 4.5 Explain the Construction of Equilibrium diagram for an Isomorphous System.
- 4.6 Define
 - a) Liquidus line
 - b) Solidus line
 - c) Tie line
- 4.7 State Lever Rule and its applications.
- 4.8 State the phase rule and explain the terms
 - a) Phase.
 - b) Number of components.
 - c) Degrees of freedom
- 4.9 State the applications of phase rule in Binary phase diagrams.
- 4.10 Explain the Cooling of an alloy in Isomorphous System by showing the microstructures at various points during Solidification.
- 4.11 Calculate the amount of phases at various temperatures in Isomorphous System using Lever Rule.
- 4.12 Define an Eutectic reaction.
- 4.13 Draw the equilibrium diagrams of Eutectic systems with examples.
- 4.14 Explain the cooling of eutectic, hypoeutectic and hypereutectic alloys showing the microstructures at various points during Solidification.
- 4.15 Calculate the amount of phases at various temperatures in Eutectic systems using Lever Rule
- 4.16 State property variations in Eutectic system.
- 4.17 Define Peritectic reaction.
- 4.18 Draw the equilibrium diagram of a peritectic system with examples.
- 4.19 Define eutectoid reaction.
- 4.20 Define peritectoid reaction
- 4.21 Define monotectic reaction
- 4.22 Define Syntectic reaction

5.0 Study of Iron – Carbon System

- 5.1 Define Allotropy and list the examples
- 5.2 State the allotropic transformation in pure iron and curie temperature,
- 5.3 State the importance and characteristics of iron – Carbon system.
- 5.4 Draw the Phase Diagram of Iron – Iron Carbide System.

- 5.5 Define a) Austenite b) Ferrite c) Cementite d) Ledeburite e) Pearlite
- 5.6 Define steel and cast iron.
- 5.7 State the differences between cast iron and steel.
- 5.8 Explain the Isothermal transformations in Iron–Iron Carbide System.
a) Peritectic b) Eutectic c) Eutectoid
- 5.9 Define Eutectoid, Hypo & Hyper eutectoid steels.
- 5.10 Explain the phase transformations during slow cooling for Eutectoid, Hypo & Hyper eutectoid steels with the help of microstructures.
- 5.11 Calculate the amount of phases at various temperatures using Lever Rule.
- 5.12 State the upper & lower critical temperatures.
- 5.13 State the effect of carbon on mechanical properties of steel.
- 5.14 Classify cast irons and draw their microstructures.

6.0 Study of Important Non-ferrous binary systems.

- 6.1 Draw the Copper-Zinc equilibrium diagram up to 60% Zinc.
- 6.2 Explain the peritectic reaction in Copper-Zinc system.
- 6.3 List out the different types of brasses.
- 6.4 State the composition, properties and applications of alpha brasses.
- 6.6 Explain season cracking and its remedies.
- 6.6 State the composition, properties and applications of alpha + beta brasses .
- 6.7 Draw the typical microstructures of alpha and alpha + beta brasses .
- 6.8 State the composition of high tensile brass
- 6.9 Draw the equilibrium diagram for Copper-Tin System.
- 6.10 Explain the peritectic reactions in Copper-Tin System.
- 6.11 State the composition, properties and applications of
a) Phosphor Bronze b) Gun metal c) Aluminum bronze.
- 6.12 State the composition, properties and applications of Copper Nickel alloys
- 6.13 Draw equilibrium diagram for Aluminum-Silicon System.
- 6.14 Explain the cast structure of Aluminum-Silicon eutectic.
- 6.16 Explain the modification treatment and modified structure of Aluminum-Silicon eutectic.
- 6.16 Draw Lead-Tin equilibrium diagram.
- 6.17 Draw Lead-Antimony equilibrium diagram.
- 6.18 State the composition, properties and applications of Babbitts
- 6.19 Draw the typical microstructure of Babbitts.

7.0 Characterization of Metals.

- 7.1 List the various parts of a microscope.
- 7.2 Explain the principle & operation of a metallurgical microscope with the help of line diagram.
- 7.3 State the various types of objective lenses.
- 7.4 State the various types of microscope eyepieces.
- 7.5 State the properties of objective lenses
a. Magnifying power
b. Numerical aperture
c. Resolving power
d. Vertical resolution
- 7.6 State the working principle of Scanning & Transmission Electron microscope.

- 7.7 Compare Optical & Electron Microscope.
- 7.8 Define Macroscopic Examination & Microscopic Examination.
- 7.9 State the importance of macroscopic examination.
- 7.10 State the importance of Microscopic examination.
- 7.11 Explain the Steps involved in the preparation of specimen for Microscopic examination.
a) Mounting b) Polishing c) Etching.
- 7.12 Explain the etching mechanism.
- 7.13 List the etchants for important Ferrous and Non-ferrous metals and alloys.
- 7.14 State the principle and use of X-ray diffraction
- 7.15 State the principle and use of Optical Spectrometer

COURSE CONTENTS

- 1.0 Crystal Structure:** Define Metallic Bond, Space lattice, Unit cell, classify crystal systems into space lattices, Lattice parameter, Co-ordination Number, Effective Number of atoms, Calculate “c/a” ratio for HCP, packing factor of BCC, FCC, HCP Structures.
- 2.0 Diffusion:** Define Diffusion, State Fick’s laws of Diffusion, effect of Temperature on Diffusion, types of Diffusion Mechanisms.
- 3.0 Solidification of Metals and Alloys:** Differentiate Metal & Alloy, types of Solid phases, Cooling curves, process of crystallization with respect to Nucleation, Grain growth & under cooling, Dendritic Growth & Coring, Homogeneous & Heterogeneous Nucleation
- 4.0 Binary thermal Equilibrium Diagrams:** Phase rule and Define Equilibrium diagram, usefulness of Equilibrium diagrams, Classification of Binary Systems, Understand Equilibrium diagrams of different Alloy Systems, Solidus line, Liquidus line, Tie line Rule & Lever Rule, Application of Phase rule to Binary phase diagram.
- 5.0 Study of Iron-Carbon diagram:** Allotropy Transformations in pure Iron, curie temperature, meta-stable phase, iron – Carbon system, Isothermal Transformations Iron – Carbon System, Hypo & Hyper eutectoid steels, transformations during slow cooling - for different steels, upper & lower critical temperatures, effect of Carbon on Mechanical properties of steel, Classification of Cast irons
- 6.0 Study of Important Non-ferrous binary systems :** Copper-Zinc equilibrium diagram up to 60% Zinc, different brasses, season cracking and its remedies, Copper, Nickel alloys with composition and applications, equilibrium diagram of Copper-Tin System, Aluminum-Silicon equilibrium diagram, modified structure of Aluminum-Silicon eutectic, Lead-tin equilibrium diagram, Lead-Antimony equilibrium diagram, Babbitt metal.
- 7.0 Characterization of Metals:** Parts of a microscope, principle & operation of a metallurgical microscope, objective lenses and eye pieces, their usefulness, Working principle of Scanning & Transmission Electron microscope, Macroscopic Examination & Microscopic Examination, Steps involved in the preparation of specimen for Microscopic examination, etching mechanism, types of etchants. Principle and use of X-ray diffraction and Optical spectrometer.

Reference Books

1. Introduction to physical metallurgy - Sydney H. Avenner
2. Physical metallurgy - V.Raghavan
3. Physical metallurgy for engineers - Clark&Warney
4. Physical metallurgy - Lakhtin
6. Metallurgy for engineers - Rollason
6. Materials science and Metallurgy - kodigere

IRON MAKING

Subject Title	:	Iron Making
Subject Code	:	Met – 305
Periods/Week	:	05
Periods per Semester	:	75

TIME SCHEDULE

S No	Major Topics	Periods	Weightage of Marks	Short Questions	Essay Questions
1	Iron ores and their preparation	12	16	2	1
2	Burden distribution	7	13	1	1
3	Blast furnace profile & reactions	10	13	1	1
4	Blast furnace plant & equipment	10	13	1	1
5	Blast furnace operations	16	26	2	2
6	Alternate methods of pig iron production	10	16	2	1
7	Recent trends in Blast Furnace operations	10	13	1	1
	Total	75	110	10	8

OBJECTIVES

On the completion of the course the student will be able to understand:

1.0 Introduction of iron making

- 1.1 List various types of iron ores.
- 1.2 Give the chemical composition, specific gravity of various ores
- 1.3 Know the chemical analysis of iron ore
- 1.4 Classify the iron ores based on colour and gangue material associated
- 1.5 State the importance of evaluation of ores
- 1.6 Explain the factors in the evaluation of ores
- 1.7 Mention reserves of iron ores in India
- 1.8 List the sources of iron ores for various steel plants in India
- 1.9 State the need of preparation of iron ores for charging into blast furnace
- 1.10 State the different Methods of preparation of iron ores
- 1.11 Define the term agglomeration
- 1.12 State purpose of agglomeration
- 1.13 Identify the different Methods of agglomeration
- 1.14 Define the term sintering
- 1.15 State the principle of sintering
- 1.16 Identify the factors affecting sintering
- 1.17 Explain the construction and operation of Dwight Lloyd sintering machine
- 1.18 Know various types of sinters.
- 1.19 Define the term pelletizing
- 1.20 State the principle of pelletizing

- 1.21 Explain the process of palletising-disc and drum pelletizing
- 1.22 Appreciate the advantages and disadvantages of pellets over sinter

2.0 BURDEN DISTRIBUTION

- 2.1 Define the term blast furnace burden.
- 2.2 Explain the charging methods of raw materials in blast furnace.
- 2.3 State the importance of burden distribution.
- 2.4 State the methods of distributing the burden inside the furnace
- 2.5 Explain the factors effecting burden distribution.

3.0 Blast furnace profile and reactions

- 3.1 Explain the profile of Blast furnace
 - i) Throat ii) Stack iii) Bosh iv) Hearth
- 3.2 Know the lining details of blast furnace
- 3.3 State the causes for the failure of the lining
- 3.4 Understand the term useful volume of Blast Furnace
- 3.5 State the raw materials required
- 3.6 State the purpose of adding coke and lime stone
- 3.7 Explain the reactions in various zones of blast furnace with reference to the descending column of raw materials and ascending column of gases
- 3.8 Define direct & indirect reduction
- 3.9 Define coke rate & importance of Co/Co₂ ratio
- 3.10 List the main product and other by – products of blast furnace
- 3.11 Identify the constituents of ascending gases and state its use.

4.0 Blast furnace plant and equipment

- 4.1 Draw the layout of blast furnace plant.
- 4.2 List the sections in Blast furnace plant.
- 4.3 Know the methods of raw material storage and its supply to the blast furnace
- 4.4 Explain the construction and operation of hot blast stove.
- 4.5 State the principle of dust catcher, scrubber and electro static precipitator
- 4.6 Explain the operation of dust catcher , scrubber and electro static precipitator

5.0 Blast furnace Operation

- 5.1 Explain the method of starting the B/F operation
- 5.2 State the procedure of banking the furnace
- 5.3 Mention the procedure for blowing out operation
- 5.4 State the composition of pig iron
- 5.5 State the favorable conditions for the removal of Silicon, Manganese, Sulphur and Phosphorous
- 5.6 Explain the external desulphurisation by soda ash treatment.
- 5.7 Explain the ladle desiliconisation process.
- 5.8 Identify the Methods of disposing pig iron by Pig casting machine and hot metal ladles
- 5.9 State the function of blast furnace slag
- 5.10 Know the constituents of blast furnace slag and slag basicity.
- 5.11 State the by product value of slag
- 5.12 State the Methods of disposing the slag
- 5.13 List out the irregularities in blast furnace operation

5.14 Discuss the causes and remedies for each irregularity

6.0 Alternative Methods of Pig iron production

6.1 State the necessity of other Methods of pig iron production

6.2 List out the other Methods of pig iron production

6.3 Define the terms - sponge iron, Percentage of reduction and degree of metallisation

6.4 Classify sponge iron making processes.

6.5 Explain the physical chemistry of DR processes

6.6 Explain the production of DRI by coal based processes i.e rotary Kiln process

6.7 Explain the production of DRI by Gas based processes i - Midrex Process.

6.8 State the applications of DRI

6.9 State the principle of reduction smelting of iron ores

6.10 know the recent reduction smelting processes – Corex, Elred, Inred, Plasma smelting

6.11 Explain the reduction smelting of iron ores in Corex process

7.0 Recent trends in blast furnace operation

7.1 list out recent trends of blast furnace

7.2 Explain

a) Large capacity furnaces

b) High top pressure operation

c) burden preparation & burden distribution

d) oxygen enrichment

e) humidification of blast

f) fuel injection through tuyeres

COURSE CONTENTS :

1.0 IRON ORES AND THEIR PREPARATION: Types, chemical composition, classification, Evaluation, Deposits in India, Need of preparation, Methods of preparation Agglomeration Methods, Sintering, Dwight Lloyd sintering machine, Types of sinters, Pelletisation, Disc and Drum pelletisers, Comparison of sinter and pellets

2.0 BURDEN DISTRIBUTION: Raw materials, Double Bell charging, Principles of Burden distribution, factors effecting Burden Distribution

3.0 BLAST FURNACE PROFILE AND REACTIONS: Profile of Blast furnace, Construction and lining details, useful volume, constituents of Ascending gases, Reactions in various zones, Direct and Indirect reduction, CO/CO_2 ratio

4.0 BLAST FURNACE PLANT AND EQUIPMENT: Lay out, Raw material storage and supply, Hot Blast stoves, Dust catcher, scrubber, Electro static precipitator.

5.0 BLAST FURNACE OPERATION: Blowing-in, Banking, Blowing-out, Disposal of pig Iron, : Function of slag, Fusibility, Constitution, By product value, de sulphurisation Pig casting machine, Irregularities.

6.0 ALTERNATIVE METHODS OF PIG IRON PRODUCTION: Necessity, Types of Alternative methods, Sponge Iron: Rotary kiln process and Midrex process, corex process

7.0 RECENT TRENDS IN BLAST FURNACE OPERATION: Large capacity Blast Furnace, Burden preparation, High Top Pressure operation, Oxygen enrichment, Humidification of Blast, Bell less charging.

REFERENCE BOOKS

1. Iron & Steel Vol –1 by Bashforth
2. Iron making by R.H.Tupkary
3. Elements of metallurgy by D. Swaroop
4. Beyond Blast Furnace by AmitChatterjee
5. Smelting reduction of iron ores by Chatterjee
6. Sponge iron production in rotary kiln by Sarangi&sarangi
7. Principles of blast furnace iron making by A.K. Biswas

MACHINE DRAWING

Subject Code : **MET-306**
Periods/ Week : **06**
Periods/Semester : **90**

TIME SCHEDULE

S.No	Major Topics	Periods	Weightage of Marks	Short answer Questions	Essay type Questions
1	Introduction	12	-	-	-
2	Fastening Devices	18	10	02	-
3	Assembly Drawings	33	80	-	02
4	Piping Layouts and Joints	15	05	01	-
5	Welding Fabrication Drawings	12	05	01	-
	Total	90	100	04	02

Note:-

Candidate has to answer all questions in part- A and one question out of two in part- B

OBJECTIVES

Up on completion of the course the student shall be able to

1.0 Understand the importance of machine drawing

- 1.1. Explain the importance of Machine drawing.
- 1.2. Review of 1st angle and 3rd angle Projections
- 1.3. Review of Orthographic Projections and Sectional Views.

2.0 Practice the drawing of fastening devices

- 2.1. Draw the standard thread profiles.
- 2.2. Draw bolted connections to standard proportions.
- 2.3. Draw different types of screws.
- 2.4. Draw different types of rivets and riveted connections.
- 2.5. Draw different types of keys and cotters.

3.0 Understand the assembly drawing practice and procedure

- 3.1. List the sequence of steps for preparing assembly drawing.
- 3.2. Practice the assembly drawing for the given components drawing.
- 3.3. Prepare the list of parts.

4.0 Formulate piping layouts and joints

- 4.1. State the distinction between pipes and tubes.
- 4.2. Identify the common components of a piping layout.
- 4.3. Identify the conventional symbols used for the various components of piping layout.
- 4.4. Prepare single line and double line diagrams of piping layouts.
- 4.5. Draw the assembly drawing and sectioned views of pipe joint.
- 4.6. Explain the use of packing material in joint.

5.0 Appreciate welded fabrication drawing.

- 5.1. Identify the different types of welds and their symbolic representation as per B.I.S., SP-46-1988.
- 5.2. Identify the elements of welding symbol and their standard location on the symbol.
- 5.3. State welding process to be used, surface contour and finish of weld when given in symbolic form.
- 5.4. Practice the Preparation of working drawing of welded fabrications.

Key competencies to be achieved by the student

Topic	Key competency
Introduction	<ul style="list-style-type: none">• Understand the difference between I & III angle projections• Appraise the importance of sectional views in Mechanical Engineering
Fastening devices	<ul style="list-style-type: none">• Differentiate the temporary and permanent joints and their applications• Draw the bolts, screws, nuts, rivets, keys and cotters with standard proportions
Assembly drawing	<ul style="list-style-type: none">• Read the external and internal features of each part• Prepare the table of parts giving part number, its name, material and quantity
Piping layouts	<ul style="list-style-type: none">• Acquaint with the symbols used for the various components of piping layout• Understand the importance and use of all the valves and packing material used in pipe fittings
Welded fabrication drawing	<ul style="list-style-type: none">• Specify the weld joint• Prepare the working drawing of welded fabrications.

COURSE CONTENT

1.0 Introduction

- 1.1. Importance of Machine Drawing.
- 1.2. Brief revision of 1st and 3rd angle projections
- 1.3 Understand the concepts of Orthographic projections and Sectional views.

2.0 Fastening Devices.

- 2.1. Temporary and Permanent fastenings and their areas of application-thread nomenclature, forms of screw thread profiles, metric, B.A., Acme, Knuckle, etc.
- 2.2. Bolts and Nuts: Specification of bolts and nuts, Different types of bolted joints in different applications
- 2.3. Keys and cotters: Types of keys and cotters: Difference between key and cotter uses.
- 2.4. Rivets and Rivetted joints: Types and proportions and specification of rivets :Different types of riveted joints: Lap, butt-single chain and zig-zag riveting – calculation of diameter of rivet: Pitch and arrangement of rivets in row – use – of standard proportions.

Drawing Plate: 1

1. Thread Nomenclature and forms of screw thread profiles.
2. Exercises in drawing – bolted connections using standard proportions.
3. Drawing of various types of lock nuts & types of keys indicating their proportionate dimensions.
4. Exercise in drawing riveted joints using standard proportions: Single row, double row (chain and zig-zag) in lap and butt joints (single).

3.0 Assembly Drawings.

- 3.1. Need and functions of assembly and detailed drawings.
- 3.2. Steps in preparing assembly drawings.
- 3.3. Bill of materials and parts list.
- 3.4. Exercises in preparing assembly drawings of commonly available engineering components.

Drawing Plate:2

Draw the views / sectional views of

1. Jib and cotter joint assembly
2. Knuckle joint assembly
3. Screw jack assembly,
4. Stuffing box.
5. Bearings.

NOTE: With the knowledge gained by the above exercises students must be able to draw exercises on Socket and spigot joint, cross head, connecting rod, eccentric, flexible coupling, universal coupling, sleeve and cotter joint, big end of a connecting rod, foot step bearing, Plummer block.

4.0 Piping layouts.

- 4.1. Classification of pipes and tubes.
- 4.2. Components of pipes lay-out.
- 4.3. Screw fitting bend, elbow, tee, lateral Cross-nipple, reducing socket and plug.
- 4.4. Unions: screwed, ground and flanged.
- 4.5. Valves: Gate valve: angle valve, check valve.
- 4.6. Various conventional symbol used for the above components.

Drawing Plate: 3

1. Single line diagram of pipe layout two exercises.
2. Double line diagram of pipe layout one exercise.
3. Cast iron flanged pipe joint, spigot and socket joint, screwed joint, union joint - draw half sectional elevation and end view.

5.0 Welded fabrication drawings.

- 5.1. Different types of weld and their basic symbols including sectional representation as per table of I.S. standards, fillet, square butt, single V-Butt, double V-Butt, single bevel butt, double bevel butt, stud, spot, seam.
- 5.2. Elements of welding symbol and their standard location the symbol as per IS standards reference Kode arrow head, weld symbol supplementary symbol dimensions of welds.
- 5.3. Supplementary symbols and special instructions: surface of reference line; as per I.S. standards with reference to fillet, V-Butt an stud welds.

Drawing Plate: 4

1. Drawing tables and figs. Referred in the contents above taking form I.S. standards.
2. Preparing working drawing of welding fabrication from given data.

REFERENCE BOOKS

1. T.S.M & S.S.M in respect of Technical Drawing by TTTI, Madras
2. Machine Drawing by A.C. Parkinson.
3. Machine Drawing by N.D. Bhat.
4. A text book for Technical Schools Engg. Drawing by N.C.E.R.T
5. Machine Drawing by R.B. Gupta.
6. Indian Standard Scheme of symbol for Welding by SP-46-1988.
7. Machine Drawing by N.Siddeswar, Kannaih, Sastri. (MGH Publishers)

FUELS LAB

Subject Title : **Fuels Lab**
Subject Code : **Met – 307**
Total No. of Periods : **03**
Total Periods Per Semester : **45**

TIME SCHEDULE

Sl.No.	Experiment Title	No. of periods
1	Proximate analysis	09
2	Flash point & Fire point	09
3	Viscosity	09
4	Calorific value	09
5	Cloud point and Pour Point	09
Total periods		45

OBJECTIVES

Up on Completion of the course the student shall be able to:

1.0 To estimate the amount of moisture , volatile matter , ash and fixed carbon of given sample of coal

- 1.1 Define proximate analysis
- 1.2 Types of moisture contents in coal
- 1.3 Working of oven
- 1.4 Handling of apparatus
- 1.5 Observing and manipulating of furnace temperature
- 1.6 Use empirical formulae to determine moisture, volatile matter, ash and fixed carbon of given sample of coal
- 1.7 Explain the need and scope of the Experiment in industry

2.0 Understand the determination of flash and fire point of a given sample of fuel using given apparatus

- 2.1 Define the flash and fire points of fuels.
- 2.2 Distinguish between “open” and “close” tests.
- 2.3 Identify the Parts of apparatus
- 2.4 Explain the function of each component part
- 2.5 Handle the apparatus
- 2.6 Manipulate the apparatus
- 2.7 Perform the precise operations to determine flash and fire point of given sample of fuel
- 2.8 Record the observations
- 2.9 List the Precautions and safety procedures
- 2.10 Explain the need and scope of the Experiment in industry

3.0 Understand the determination of Viscosity of a given sample of oil using given apparatus

- 3.1 Explain the properties of lubricating oil
- 3.2 Explain the viscosity of oil and its units
- 3.3 Explain the importance of viscosity as applied to Oils.
- 3.4 Relate the Absolute viscosity and kinematic viscosity

- 3.5 Classify the viscometers
- 3.6 Identify the parts of viscometer
- 3.7 Handle the apparatus
- 3.8 Manipulate the apparatus
- 3.9 Perform the precise operations to record Redwood seconds
- 3.10 Use empirical formulae to determine the Kinematic & Absolute viscosities of given Oil.

4.0 Understand the calculation of Calorific value of a given sample of fuel using calorimeter

- 4.1 Explain the phenomenon of combustion of fuel
- 4.2 Explain the calorific value of fuel
- 4.3 State the differences between higher and lower Calorific values of fuels.
- 4.4 List the types of fuels
- 4.5 Study the procedure for the determination of calorific value by using bomb, and Junker's Calorimeter to record various parameters (Theory only).

5.0 Understand the determination of Cloud and Pour point

- 5.1 Define the cloud and pour points of oils.
- 5.2 Distinguish between cloud and pour points.
- 5.3 Identify the Parts of apparatus
- 5.4 Explain the function of each component part
- 5.5 Handle the apparatus
- 5.6 Manipulate the apparatus
- 5.7 Perform the precise operation to record the results.

KEY competencies to be achieved by the student

COURSE CONTENT

1. Estimate the amount of moisture, volatile matter, ash & fixed carbon of given coal sample
2. Determination of flash and fire points of various fuels and lubricants using Pensky Martin's, and Cleveland's apparatus.
3. Determination of Kinematics and Absolute viscosities of the fuel and lubricating Oils using Redwood viscometers.
4. Theoretical calculation of Calorific values of Solid and liquid fuels using Calorimeter
5. Determine the cloud and pour point of given oil.

Title of the experiment	Key competency
1. Proximate analysis	<ol style="list-style-type: none"> 1. Weigh the porcelain crucible with and without coal sample. 2. Place the bowl in oven and furnace 3. Opening and closing of furnace
2. Flash and Fire point tests	<ol style="list-style-type: none"> 1. Observe the flame for change in color and type of flame 2. Record the temperature of fuel using thermometer
3. Viscosity measurement	<ol style="list-style-type: none"> 1. Handle the Hydrometer to measure the density of given oil 2. Record the temperature of oil using thermometer 3. Record the time to collect 60 ml of oil
4. Calorific value tests	<ol style="list-style-type: none"> 1. Theoretical calculations of calorific values of solid, liquid, and gaseous fuels using calorimeters.
5. Cloud and Pour points of oil	<ol style="list-style-type: none"> 1. Determination of cloud and pour points of a given oil using the apparatus. 2. Record the temperature using thermometer.

METALLOGRAPHY LAB

Subject Title	:	Metallography Lab
Subject Code	:	Met – 308
Total No. of Periods	:	06
Total Periods Per Semester	:	90

TIME SCHEDULE

Sl.No.	Experiment Title	No. of periods
1	Metallurgical microscope	06
2	Preparation of specimen	12
3	Etching reagents	06
4	Microstructures of steels and cast irons	24
5	Microstructures of stainless steel, case hardened steel and weld steel	24
6	Microstructures of non ferrous metals	18
		90

OBJECTIVES

Up on Completion of the course the student shall be able to:

- 1.0 **Operating a metallurgical microscope**
 - 1.1 To know the parts of metallurgical microscope
 - 1.2 Able to know coarser adjustment and finer adjustment
 - 1.3 Handling of apparatus
 - 1.4 Placing of prepared specimen under the objective lens
 - 1.5 Eye pieces of different magnifications
 - 1.6 Resolving power in metallurgical microscope
 - 1.7 Differences between micro and macro examination
- 2.0 **Prepare a specimen for metallographic examination**
 - 2.1 To know the rough grinding equipment
 - 2.2 Parts of rough grinding equipment
 - 2.3 Grades of emery papers for intermediate polishing
 - 2.4 To know the way of polishing specimen on emery paper
 - 2.5 Mixing of alumina powder with water for fine polishing
 - 2.6 Parts of fine polishing machine
- 3.0 **Preparation of etching reagents for ferrous and non ferrous metals**
 - 3.1 Identify the etching reagents used for ferrous and non ferrous metals
 - 3.2 To know the composition of chemicals for preparation of etching reagents
 - 3.3 Effect of etching reagent on polished specimen
 - 3.4 Difference between under etching and over etching
 - 3.5 To know about the etching techniques

4.0 Microstructures of steels and cast irons

- 4.1 Identify the phases in the Low, medium and high carbon steels
- 4.2 Identify the phases present in gray cast iron
- 4.3 Identify the phases present in nodular cast iron
- 4.4 Identify the phases present in malleable cast iron
- 4.5 Identify the phases present in white cast iron

5.0 Microstructures of stainless steel, case hardened steels and weld steels

- 5.1 Identify the phases present in stainless steel
- 5.2 Identify the phases present in case hardened steel
- 5.3 Observation of heat affected zone in weld sample
- 5.4 Identify the phases present in case and core parts of weld sample

6.0 Microstructures of brass, bronze and aluminium alloys

- 6.1 Identify the phases present in brass sample
- 6.2 Identify the phases present in bronze sample
- 6.3 Phases present in aluminium alloys

KEY competencies to be achieved by the student

Title of the experiment	Key competency
1. Metallurgical microscope	1. Adjustment of coarser and finer knobs 2. Placing the sample on mounting table 3. Observing the microstructure
2. Preparation of specimen	1. Selection of proper sample 2. Selecting the order of different grades of emery papers for polishing 3. Way of polishing on emery paper 4. Fine polishing on disc polisher
3. Etching reagents	1. Selecting reagents for ferrous and non ferrous metals 2. Applying the etching reagent on prepared specimen surface 3. Etching techniques and etching time
4. Microstructures of steels and cast irons	1. Identify the phases in microstructure 2. Different types of steel and cast iron microstructures
6. Microstructures of stainless steel, case hardened steel and weld steel	1. Identify the phases in microstructure stainless steel 2. Identify the phases present in case hardened steel 3. Phase distribution in weld steels
6. Microstructures of non ferrous Metals	1. Identify the phases present in microstructure 2. Identify the inclusions present in microstructure

COURSE CONTENT

1. Operating a metallurgical microscope
2. Prepare a specimen for metallographic examination
3. Preparation of etching reagents for ferrous and non ferrous metals Microstructures of steels and cast irons
4. Microstructures of stainless steels, case hardened steels and weld steels
5. Microstructures of brass, bronze and aluminium alloys

MINERAL DRESSING LAB

Subject Title : **Mineral Dressing Lab**
Subject Code : **Met -309**
Periods / Week : **03**
Periods / Year : **45**

TIME SCHEDULE

Sl.No	Experiment Title	No. of Periods
1	Jaw crusher	06
2	Roll Crusher	06
3	Ball Mill	06
4	Rod Mill	06
5	Rotap sieve shaker	06
6	Vibrating Screens	03
7	Mineral Jig	06
8	Floatation cell	06
Total periods		45

OBJECTIVES

Up on the completion of the course the student shall be able to:

1. Determine the energy consumption as a function of size reduction by using Jaw crusher and verify the energy consumption & size reduction relationship with Crushing laws - Kicks law and Rittinger's law
2. a) Determination of energy consumption as a function of size reduction by using roll crusher verify the energy consumption & size reduction relationship with Crushing laws - Kicks law and Rittenger's law
b) Determination of energy consumption as a function of size reduction by using roll crusher and Calculate the angle of NIP of roll crusher.
3. Study the effect of the following variables on grinding in a Ball Mill
a) Determination of energy consumption as a function of size reduction
b) Variation of energy consumption as a function of time of reduction.
4. Study the effect of following variables on grinding in a Rod Mill.
a) Determination of energy consumption as a function of size reduction
b) Variation of energy consumption as a function of time of reduction.
5. Perform the Sieve analysis of the given material by using Rotap sieve shaker and Plot the following graphs
a) size in microns vs. percentage Wt. Retained by individual sieve by using ASTM/BSS sieves.
b) Size in micros vs. Cumulative weight percentage coarse & finer
6. Determination of effectiveness of screening in separating the given material by use of Vibrating

screens

7. Concentrate the given Mineral by using the mineral Jig
 - a) Through the screen
 - b) above the screen.
8. Study the flotation characteristics of a sulphide ore using a Froth Flotation cell.

Key competencies to be learnt by the student after completion of each experiment:

Experiment	Key competencies to be learnt
Jaw crusher	<ol style="list-style-type: none"> 1. Construction of Jaw crusher 2. Reduction ratio 3. Equation for power consumed 4. How to read the energy meter readings 5. Kick's law and Ritterger's law 6. Calculation of average size of feed and product 7. Industrial applications of Jaw crusher
Roll crusher	<ol style="list-style-type: none"> 1. Construction of Roll crusher 2. Reduction ratio 3. Equation for power consumed 4. How to read the energy meter readings 5. Kick's law and Ritterger's law 6. Calculation of average size of feed and product 7. Measurement of circumference of roll thereby its diameter 8. Equation for angle of NIP 9. Industrial applications of Roll crusher
Ball mill	<ol style="list-style-type: none"> 1. Construction of Ball mill 2. Reduction ratio 3. Equation for power consumed 4. How to read the energy meter readings 5. Critical speed of the mill 6. Calculation of average size of feed and product 7. Open circuit grinding and closed circuit grinding 8. Industrial applications of ball mill
Rod mill	<ol style="list-style-type: none"> 1. Construction of Ball mill 2. Reduction ratio 3. Equation for power consumed 4. How to read the energy meter readings 5. Critical speed of the mill 6. Calculation of average size of feed and product 7. Open circuit grinding and closed circuit grinding 8. Industrial applications of Rod mill
Rotap sieve shaker	<ol style="list-style-type: none"> 1. Know BSS, ASTM and classification of sieves 2. Relation between aperture size and sieve number 3. Need of measuring average size of the particles

	<ol style="list-style-type: none"> 4. Equation for determining average size of the particle 5. Working mechanism of Rotap sieve shaker 6. Interpretation of graph between size in microns vs. percentage Wt. Retained by individual sieve by using ASTM/BSS sieves. 7. Size in microns vs. cumulative weight percentage coarse & finer 8. Industrial applications of sieve analysis
Vibrating screens	<ol style="list-style-type: none"> 1. Know BSS, ASTM and classification of sieves 2. Relation between aperture size and sieve number 3. Need of separation of particles 4. Effect of blind particle on the effectiveness of screen 5. Mechanism of vibrating screen 6. Calculation of weight fractions on each sieve 7. Industrial applications of Vibrating screens
Mineral Jig	<ol style="list-style-type: none"> 1. Mineral, Ore and concentrate 2. Interpretation of Stoke's law 3. Renaults number 4. Free settling and hindered settling 5. Terminal velocity and settling velocity of the particles 6. Settling of small dense particle and coarse light particles 7. Suction and pulsation 8. Industrial applications of Mineral jig
Flotation cell	<ol style="list-style-type: none"> 1. Purpose of agitation of bath 2. Hydrophobic particles and aero phobic particles 3. Purpose and names of frother, collector, activator and depressors 4. Industrial applications of Froth flotation

COURSE CONTENT:

1. Determination of the energy consumption as a function of size reduction by using Jaw crusher and verification of the energy consumption & size reduction relationship with Crushing laws - Kicks law and Rittenger's law
2. Determination of energy consumption as a function of size reduction by using roll crusher verify the energy consumption & size reduction relationship with Crushing laws - Kicks law and Rittenger's law – Calculation of angle of NIP
3. Study the effect of the following variables on grinding in a Ball Mill and Rod mill

- a) Determination of energy consumption as a function of size reduction
- b) Variation of energy consumption as a function of time of reduction.
- 4. Perform the Sieve analysis of the given material by using Rotap sieve shaker and Plot the necessary graphs
- 5. Determination of effectiveness of screening in separating the given material by use of Vibrating screens
- 6. Concentrating the given Mineral by using the mineral Jig
- 7. Study the flotation characteristics of a sulphide ore using a Froth Flotation cell.

IV –SEM
(C-16)

METALLURGICAL THERMODYNAMICS

Subject Title	: Metallurgical Thermodynamics
Subject Code:	: Met-401
Periods per week	: 05
Periods per Semester	: 75

TIME SCHEDULE

S.No.	MAJOR TOPICS	PERIODS	WEIGHTAGE OF MARKS	SHORT TYPE	ESSAY TYPE
1.	Introduction and application of thermodynamics	09	13	1	1
2.	First law of thermodynamics	12	18	1	1.5
3.	Thermo-chemistry	10	16	2	1
4.	Second law of thermodynamics	12	18	1	1.5
5.	Ellingham diagrams	05	06	2	-
6.	Phase Equilibria	09	13	1	1
7.	Fugacity, Activity, Equilibrium constant,	09	13	1	1
8.	Solutions	09	13	1	1
	TOTAL	75	110	10	8

OBJECTIVES

On the completion of the course the student will be able to understand

1.0 Introduction and applications of thermodynamics:

- 1.1 Applications of Thermodynamics
- 1.2 Define ideal gas and derive the ideal gas equation $PV=nRT$.
- 1.3 Define real gas and perfect gas.
- 1.4 Define system, surrounding & boundary with examples.
- 1.5 Distinguish between Homogeneous and Heterogeneous systems.
- 1.6 Define isolated system, closed system, open system and adiabatic system.
- 1.7 Define intensive, extensive properties, state and path properties with examples.
- 1.8 Define state of a system and equation of state.
- 1.9 Define equilibrium state and the criteria for equilibrium.
- 1.10 Explain isothermal, adiabatic, Isochoric and Isobaric process.
- 1.11 Define reversible and irreversible processes and state differences between them.
- 1.12 Explain the terms heat and work with units. (S.I. Units) state sign conventions of heat and work.
- 1.13 Explain about pressure – volume work (or) work of expansion Derive equation for work of expansion.
- 1.14 State complete / exact differential of thermodynamic properties.

2.0 First law of Thermodynamics:

- 2.1 State First law of thermodynamics.

- 2.2 Explain energy content and energy changes.
- 2.3 Derive heat changes at constant volume and constant pressure.
- 2.4 Explain concept of enthalpy or heat content.
- 2.5 Define heat capacity.
- 2.6 Define heat capacities at constant volume and constant pressure.
- 2.7 Derive the relation between heat capacities at constant volume and constant pressure.
- 2.8 State heat capacity – temperature relationships.
- 2.9 Define reversible adiabatic expansion and compression.
- 2.10 Derive the following relations in reversible adiabatic process.
 - a) Temperature - Volume relationship
 - b) Pressure – Volume relationship
- 2.11 Solve a range of problems using the above derivations and equations from the above mentioned objectives.

3.0 Thermo Chemistry:

- 3.1 Define heat of reaction.
- 3.2 Define heat of reaction at constant pressure and constant volume.
- 3.3 Define exothermic and endothermic reactions and the sign conventions of ΔH from ΔE .
- 3.4 Define heat of formation
- 3.5 Define heat of combustion.
- 3.6 State the thermo-chemical laws
 - a) Laplace Law.
 - b) Hess law of constant heat summation.
- 3.7 Explain variation of heat of reaction with temperature and derive the Kirchoff's equation..
- 3.8 Solve a range of problems using the above derivations and Equations from the above mentioned objectives.

4.0 Second law of Thermodynamics:

- 4.1 State the Second law of thermodynamics.
- 4.2 Define spontaneous and irreversible process.
- 4.3 Derive the efficiency of Carnot engine.
- 4.4 State the concept of entropy and the relation.
- 4.5 State the entropy changes in reversible and irreversible processes
- 4.6 Define entropy change and phase change.
- 4.7 State the conditions for equilibrium in terms of change in Entropy
- 4.8 Derive equation for variation of entropy with temperature.
- 4.9 State third law of thermodynamics.
- 4.10 State the concept of free energy.
- 4.11 Derive the free energy relationships.
- 4.12 State the conditions for equilibrium in terms of change in free energy.
- 4.13 Derive the Gibbs – Helmholtz Equation.
- 4.14 Define partial molar properties.
- 4.15 Define chemical potential – partial molar free energy.
- 4.16 Solve a range of problems using derivations and equations from the above-mentioned objectives.

5.0 Ellingham diagrams

- 5.1 Understand the construction of the standard free energy - temperature ($\Delta G^\circ - T$) diagram.

- 5.2 Explain $\Delta G^\circ - T$ diagram in terms of the formation of FeO, Fe₂O₃, Fe₃O₄, CO₂ & CO.
- 5.3 State the applications of $\Delta G^\circ - T$ diagram.
- 5.4 State the limitations of $\Delta G^\circ - T$ diagrams.

6.0 Phase Equilibria

- 6.1 Explain the equilibrium between phases of one component system.
- 6.2 Derive the CLAPEYRON equation.
- 6.3 State the equation for solid-liquid equilibrium, liquid-vapour Equilibrium and solid-vapor equilibrium.
- 6.4 Derive the CLASIUS CLAPEYRON equation and explain its applications.
- 6.5 State the vapor pressure-temperature relationships.
- 6.6 State Trouton's rule.
- 6.7 Solve a range of problems using derivations and equations from the above mentioned objectives.

7.0 Fugacity, Activity & Equilibrium Constant

- 7.1 Define fugacity, activity and equilibrium constant.
- 7.2 State the equation for fugacity of an ideal gas & Non Ideal gas
- 7.3 Define chemical equilibrium.
- 7.4 State Le-chatliers rule for law of mass of action.
- 7.5 Explain the factors effecting the position of equilibrium.
- 7.6 Define equilibrium constant.
- 7.7 Derive the VANTHOFF's equation for isotherm and Isochors.
- 7.8 Solve range of problems using derivations and equations in the above mentioned objectives.

8.0 Solutions

- 8.1 Define Solution, Mole Fraction, Weight % and Atom %.
- 8.2 Know the conversion of Weight % to Atom % and Atom % to Weight % .
- 8.3 Classify Solutions, Define Ideal Solution & Regular Solution.
- 8.4 State Roults law for ideal solutions.
- 8.5 Define the activity coefficient.
- 8.6 State the factors causing deviation from ideal behavior.
- 8.7 Define Dilute solution and state Henry's law.
- 8.8 State Sieverts law and its applications.
- 8.9 Solve range of problems using derivations and equations in the above mentioned objectives.

COURSE CONTENTS:

1.0 INTRODUCTION TO THERMODYNAMICS:

Applications, Ideal gas equation, system & types, properties of system, equilibrium state, thermodynamic processes, work of expansion.

2.0 FIRST LAW OF THERMODYNAMICS:

Introduction, Heat change, Heat capacity, relation between Cp&Cv, enthalpy, Heat capacity & temperature relationship.

3.0 THERMOCHEMISTRY.

Heat of relation, Heat of formation, heat of combustion, endothermic & exothermic reactions, thermo chemical laws, solve a range problems.

4.0 SECOND LAW OF THERMODYNAMICS

Introduction, Carnot cycle, Entropy changes, free energy, Gibbs- helmoltz equation, chemical potential , partial molar properties, solve a range of problems.

5.0 ELLINGHAM DIAGRAMS

Construction, Ellingham diagram for formation of FeO, Fe₂O₃ , Fe₃O₄,and CO ,uses and limitations.

6.0 PHASE EQUILIBRIA

ClasiusClapeyron equation, equation for solid- liquid, liquid-vapour& solid–vapour equilibrium, Troutons rule, solve a range problems.

7.0 FUGACITY, ACTIVITY & EQUILIBRIUM CONSTANT

Introduction, fugacity of an ideal & non-ideal gas, position of equilibrium, Vanthoff equation, solve a range problems.

8.0 SOLUTIONS

Definitions, classification, Renaults law & ideal solution, Henry's law & dilute solution, sieverts law, regular solution, solve a range problems

REFERENCE BOOKS

1. Thermodynamics for chemists- by S. Glasstone.
2. Problems in metallurgical
Thermodynamics and kinetics- by Dube and Upadhyaya
3. Chemical metallurgy- by J.J. More.
4. Physical chemistry of Metals- by Darken & Gurry.
5. Metallurgical thermodynamics- by Gaskel.

MATERIAL TESTING

Subject Title	:	Material Testing
Subject Code	:	Met-402
Periods/Week	:	04
Periods per Semester	:	60

TIME SCHEDULE

S.No	Major Topics	Periods	Weightage of Marks	Short Type	Essay Type
1.	Tension test	10	23	1	2
2.	Hardness test	8	16	2	1
3.	Fracture	7	13	1	1
4.	Impact test	6	13	1	1
5.	Fatigue test	8	16	2	1
6.	Creep test	6	13	1	1
7	Non – Destructive testing	9	16	2	1
	Total	60	110	10	8

OBJECTIVES

On completion of this subject the student should be able to Understand

1.0 TENSION TEST

- 1.1 Know the importance of tension test in industrial application.
- 1.2 Define stress & strain
- 1.3 Plot the Engineering stress – strain curve from the data.
- 1.4 Explain the salient features of the stress – strain curve.
- 1.5 Identify the specifications of test samples for tension test
- 1.6 Define the important tensile properties viz., UTS, YS. Proof stress percentage elongation and percentage reduction in area, resilience, toughness
- 1.7 Calculate the above properties from the test data.
- 1.8 Numerical problems on tensile data
- 1.9 Draw the stress – strain curve for ductile and brittle material.
- 1.10 Define true stress true strain.
- 1.11 Convert the engineering strain to the true strain
- 1.12 Convert engineering stress to true stress
- 1.13 Know Flow curve, mathematical equation.
- 1.14 Define the importance of flow curve properties viz., true stress at maximum load, true uniform strain, true local necking strain, true fracture stress
- 1.15 Explain the necking phenomenon.
- 1.16 Derive the two conditions for necking viz., the true stress is equal to the slope of the flow curve and true strain equals to the strain hardening coefficient
- 1.17 Define modulus of elasticity, modulus of rigidity, Bulk modulus, Poission's ratio.

- 1.18 Know the relation between the above four.
- 1.19 Discuss the effect of temperature on tensile properties.

2.0 Hardness test:

- 2.1 Know the importance of hardness test.
- 2.2 Define hardness & Classify hardness tests.
- 2.3 State the scratch hardness & Name different minerals in Moh's hardness scale
- 2.4 Tell the principle of Brinell hardness test.
- 2.5 Tell different Indentors and loads used for different materials.
- 2.6 Know the test procedure of BHN test.
- 2.7 Understand the terms "Ridging" and "Sinking in".
- 2.8 Measure the indentation diameter with the help of eyepiece.
- 2.9 Derive BHN formula.
- 2.10 Calculate the hardness number using BHN formula.
- 2.11 Find the industrial importance of Brinell hardness test.
- 2.12 Tell the principle of Vickers's hardness test.
- 2.13 Tell the Indentors and loads used.
- 2.14 Know the test procedure of VHN test.
- 2.15 Measure the diagonal length of impression with the help of microscope.
- 2.16 Calculate the hardness number from the test data.
- 2.17 Find the industrial importance of Vickers's hardness test.
- 2.18 Tell the principle of Rockwell hardness test.
- 2.19 Tell different combinations of Indentors and loads used.
- 2.20 Explain the description of the dial.
- 2.21 Read the hardness value from the dial.
- 2.22 Convert the Rockwell to brinell hardness number.
- 2.23 Tell the principle of Rockwell superficial hardness test.
- 2.24 Tell the importance of Rockwell superficial hardness test.
- 2.25 Tell the different Indentors and the loads used.
- 2.26 Find the applications of Tukon hardness test.
- 2.27 Calculate the Knoop hardness number from the test data.
- 2.28 Discuss the importance of Rebound hardness test.
- 2.29 State the industrial applications of Shore scleroscope.

3.0 Fracture:

- 3.1 Know what is fracture.
- 3.2 Differentiate the ductile and brittle fracture.
- 3.3 Derive the equation for theoretical cohesive strength.
- 3.4 Explain the Griffith theory of brittle fracture.
- 3.5 Analyse different metallographic aspects of fracture.

4.0 Impact test:

- 4.1 Identify the specifications of test samples for conducting Izod and Charpy tests.
- 4.2 Explain the principle of operation of Izod and Charpy impact tests.
- 4.3 Define notch sensitivity.
- 4.4 Define notch toughness
- 4.5 Define transition temperature.
- 4.6 Know the factors which effect transition temperature.

5.0 Fatigue test:

- 5.1 Know the importance of the fatigue test.
- 5.2 Explain the different cycles of stress – Alternating, Repeating & fluctuating.
- 5.3 Explain loading systems – reverse bend, torsion and tension- compression.
- 5.4 Plot the S-N curve from the test data and identify the endurance limit
- 5.5 Discuss typical fatigue failure.
- 5.6 State the theories of fatigue – Orowon's and Wood's concept.
- 5.7 Discuss the effect of stress concentration on fatigue.
- 5.8 Discuss the effect on surface roughness on fatigue.
- 5.9 Discuss the effect of surface residual stress on fatigue.
- 5.10 Discuss the effect of corrosion on fatigue properties.
- 5.11 Explain the effect of metallurgical variables on fatigue properties.
- 5.12 Explain the effect of temperature on fatigue properties.
- 5.13 Identify the specifications of test samples for fatigue test.

6.0 Creep test

- 6.1 Define creep.
- 6.2 Know the importance of creep test.
- 6.3 Know the essential features of creep test.
- 6.4 Explain the creep curve and its regions.
- 6.5 Know the presentation of creep data.
- 6.6 Tell the mechanism of creep.
- 6.7 Know the stress – rupture test.
- 6.8 Distinguish stress – rupture test and creep test.

7.0 Non-destructive testing:

- 7.1 Explain the need of non- destructive test.
- 7.2 Know the importance of Non- destructive test.
- 7.3 Explain about Visual examination.
- 7.4 State the steps involved in dye penetrant test.
- 7.5 State the principle of magnetic particle test.
- 7.6 Know about longitudinal magnetization
- 7.7 Know about circular magnetization
- 7.8 Explain the Magnetic Particle test
- 7.9 Know the de-magnetisation methods
- 7.10 State the principle of radiography
- 7.11 Know the interpretation of radiograph.
- 7.12 Give the precautions while carrying out radiography.
- 7.13 State the importance of ultrasonic test.
- 7.14 State the principle of ultrasonic test.
- 7.15 Know the calibration of ultrasonic test.
- 7.16 Explain the test procedure for ultrasonic test.
- 7.17 Know the interpretation of ultrasonic test result.
- 7.18 State the importance of Eddy current test.
- 7.19 State the principle of Eddy current test.
- 7.20 Know the applications of Eddy current test.

COURSE CONTENTS

- 1.0 Tension test** – Introduction. Stress strain diagram – salient features. Tensile properties, effect of temperature, true stress strain diagram. Various features, necking phenomena, Elastic constants, strain measurements instruments.
- 2.0 Hardness test** – Definition of hardness, classification, various hardness tests—brinell, Rockwell, Vicker, micro hardness test, and Shorescleroscope – principles, operation and applications. Relevant derivations.
- 3.0 Fracture** – Definition, ductile and brittle fracture, cohesive strength equation, Griffith theory of brittle fracture, metallographic aspects of fracture
- 4.0 Impact test** – Test specimens, principles of operation of testing machines, Notch sensitivity, Notch toughness, transition temperature.
- 5.0 Fatigue test** – Importance, different cycles, S-N Curve, endurance limit, Fatigue failures, theory of fatigue, effect of surface, metallurgical variables and temperature on fatigue, test sample specifications.
- 6.0 Creep test** – Definition, importance, salient features of creep curve and mechanism of creep, stress rupture test.
- 7.0 Non Destructive testing** – Need for non destructive testing, Various non destructive tests, - Visual, Dye penetrant, Magnetic particle, Radiography, Ultrasonic and Eddy current test.

REFERENCE BOOKS

1. Mechanical metallurgy – by G.E. Dieter
2. The testing of metallic Materials –by A.V.K. Suryanarayana.
3. Non-destructive testing – by Barry Hull and Vernon Jhon, ELBS.
4. Principles of metallographic Laboratory Practice – by Kehl

FOUNDRY TECHNOLOGY

Subject Title : Foundry Technology
Subject Code : Met-403
Periods/Week : 05
Periods per Semester : 75

TIME SCHEDULE

S.No	Major Topics	Periods	Weightage of Marks	Short Type	Essay Type
1.	Introduction	4	3	1	-
2.	Patterns	10	13	1	1
3.	Moulding Sands	10	13	1	1
4.	Cores	8	13	1	1
5.	Moulding process	15	26	2	2
6.	Moulding Methods	10	16	2	1
7	Pouring and feeding of casting	12	16	2	1
8	Defects of casting	6	10	0	1
	Total	75	110	10	8

OBJECTIVES

On completion of the subject the student should be able to understand

1.0 Introduction

- 1.1 Define the terms foundry, casting, pattern.
- 1.2 Classify the foundries.
- 1.3 State the advantages and limitation of foundry as a production process.
- 1.4 List the basic steps involved in a casting process such as pattenmaking, core making, moulding, melting&pouring and cleanin& Inspection
- 1.5 Draw the flow sheet of a foundry plant.

2.0 Patterns

- 2.1 State the functions of a pattern:
- 2.2 List various pattern making material such as
 - i) Wood
 - ii) Metal
 - iii) Plaster of paris,
 - iv) Wax,
 - v) Quick setting compounds.
- 2.3 State the relative advantages and limitations of the above materials.
- 2.4 Mention the types of patterns such as
 - i) Single piece,
 - ii) Two piece/multi piece,
 - iii) Loose piece,
 - iv) Gated,
 - v) Match plate,

- vi) Cope and drag pattern,
 - vii) Skeleton pattern,
 - viii) Follow board,
 - ix) Sweep,
 - x) Master pattern
- 2.5 Define pattern allowance.
- 2.6 Explain various pattern allowances.
- i) Shrinkage,
 - ii) Machining,
 - iii) Draft,
 - iv) Distortion,
 - v) Mould wall movement.
- 2.7 State the importance of colour coding used on pattern.
- 2.8 Give the colours used for
- i) Machined,
 - ii) Unmachined,
 - iii) Loose piece,
 - iv) Core print,
 - v) Parting surface.

3.0 Moulding Sands

- 3.1 State the basic ingredients of molding sand.
- a) Sand grains b) Water c) Binder
- 3.2 State different types of sands used in foundry.
- a) silica b) Zircon c) olivine d) chromite
- 3.3 Define the terms – Natural sand , Synthetic sand
- 3.4 State the purpose of sand conditioning
- 3.5 Explain the properties of a good moulding Sand such as
- i) Green, dry , hot, Tensile, Compressive and shear Strengths
 - ii) Permeability.
 - iii) Refractoriness.
 - iv) Flowability.
 - v) Cohesiveness.
 - vi) Adhesiveness.
 - vii) Thermal Stability.
 - viii) Thermal expansion.
 - ix) Collapsibility.
 - x) Reusability.
 - xi) Moldability.
 - xii) Compactability.
- 3.6 Define the term Clay and list different clays
- 3.7 Explain the effects of grain size, moisture content and clay content on the properties of moulding sand
- 3.8 Write down the composition of
- i) Green Sand,
 - ii) Dry sand,
 - iii) Loam sand,
 - iv) Core sand.

- 3.9 State the use of
 - i) Facing sand,
 - ii) Parting sand,
 - iii) Back up sand
- 3.10 Define the term Sand additive
- 3.11 State the function of the additives

4.0 Cores

- 4.1 Define the term core
- 4.2 State the functions of cores
- 4.3 State the properties of core sand.
- 4.4 List the ingredients in a core sand.
- 4.5 Explain the process of core making.
 - i) Core making,
 - ii) Core backing
 - iii) Finishing and sizing of cores.
 - iv) Core assembly,
- 4.6 State the function of chaplets.

5.0 Molding processes

- 5.1 Explain the process, application and limitations of
 - i) Green sand molding,
 - ii) Dry sand molding,
 - iii) Core sand molding,
 - iv) Loam molding,
 - v) Pit and floor moulding
 - vi) Skin dried molding.
- 5.2 Distinguish between Green sand molding & dry sand molding.
- 5.3 Explain the following casting processes their application and limitation. (Briefly)
 - i) Permanent mould casting.
 - ii) Die casting Hot chamber, Cold chamber, Goose neck type,
 - iii) Centrifugal casting. Semi centrifugal, True centrifugal, Centrifuging
- 5.4 Distinguish between hot chamber & cold chamber die casting.
- 5.5 Distinguish between true centrifugal & semi centrifugal.
- 5.6 Explain the following processes..
 - a) Shell moulding.
 - b) Investment casting – Lost wax process.
 - c) Carbon dioxide process.
- 5.7 state the importance of mould and core coatings.

6.0 Moulding methods

- 6.1 Draw the neat sketches of the following hand moulding tools.
 - i) Mould boxes – cope – drag- cheek.
 - ii) Peen and Butt rammers,
 - iii) Cleaners,
 - iv) Riddle,
 - v) Gate cutter,
 - vi) Swab,

- vii) Bellows,
- viii) Vent wire,
- ix) Trowel,
- x) Mould board.
- xi) Jig,
- xii) Fixures.

- 6.2 State the uses of the above tools.
- 6.3 State the advantages of machine moulding
- 6.4 List the molding machines
 - i) Jolt machine
 - ii) Squeezer.
 - iii) jolt-squeeze Roll over draw.
 - iv) Mold or Core blower.
 - v) Sand Slinger,
- 6.5 Explain with neat sketch the operation of
 - a) Jolt-squeeze Roll over draw. b) Sand Slinger.

7.0 Pouring and feeding of casting

- 7.1 Draw a diagram for feeding system of a casting:
- 7.2 Explain the function of pouring basin Sprue. Runner. Gate. Riser.
- 7.3 State the effect of
 - i) Turbulence – Laminar steady flow
 - ii) Pouring rate.
 - iii) Pouring temperature.
 - iv) Solidification characteristics,
 - v) Freezing temperature range,
- 7.4 Define Gating Ratio.
- 7.5 Define Pressurised & unPressurised gating systems.
- 7.6 Give the suitable gating ratios for different applications.
- 7.7 Determine the dimensions of sprue, runner and gate for simple casting process.
- 7.8 List the different types of gating systems
- 7.9 State the advantages and limitations of – Top gating, Bottom gating and parting line gating
- 7.10 State the functions of Riser in casting.
- 7.11 Describe the factors involved in Riser design
 - i) modulus (Location of riser)
 - ii) Size and shape of riser
 - iii) Chvorinov's principle,
 - iv) Importance of (V/A) ratio.
- 7.12 Types of Risers – Open, Blind
- 7.13 State the Chvorinov's principle
- 7.14 Define directional & progressive solidification.
- 7.15 Explain the factors affecting directional solidification.

8.0 Defects in Castings

- 8.1 List out various casting defects:
 - a) shifts b) blow holes c) Pin holes d) Porosity
 - e) shrinkage cavity f) metal penetration. g) Rough surface.

h) Scabs i) hot tears j) cold shuts. k) mis-run

8.2 Explain the above defects with remedial measures

COURSE CONTENTS

- 1. INTRODUCTION** : Foundry as a production process, advantages and limitation of foundry. Type of foundries, Basic steps involved in a sand casting process such as pattern making, core making, moulding, melting, pouring and cleaning.
- 2. Patterns** : Pattern and its function in a foundry, Pattern making materials, Their relative advantages and limitations, **Types of patterns, Pattern allowances**, Pattern colour codes: Machined, unmachined, core prints, loose piece, parting line
- 3. Moulding Sands Sand moulds**: Green and dry sand moulds, **Properties of sand**, Shatter Index value, sand testing methods, Ingredients of moulding sand, Sand grains, Effect of clay on strength, expansion, permeability and water content. Sand conditioning its effect on mould, **Additives, Types of sands**
- 4. Cores** : Function of cores, core sands, core ingredients, core oils, core binders, **Properties of core sands, Core making**. Finishing of core & sizing core assembly, use of chaplets.
- 5 Molding processes** : i) Sand moulding : Green sand, dry sand, core sand moulds, loam moulds, pit and floor moulding, skin dried molds, Special casting processes, applications, advantages and limitations, High pressure molding, hot box process. No bake process, cold box process, replicost process fluid sand process, V- process, cement bonded molds, squeeze casting (Briefly), Gravity die casting.
- 6. Moulding Methods** : Mould boxes, peen and butt rammers cleaner, riddle, gate cutter, swab, bellows, draw spike, vent wire, mould board, trowel, (**Sketches and purpose only**), jigs and fixtures. Description and application of jolt squeezer, sand slinger roll over moulding machines, mould or core blower.
- 7. Pouring and feeding of casting**: Pouring, filling the mould. Factors involved, Shrinkage, solidification characteristics freezing temperature range & fluidity, Feeding system, Sprue design, Runners, eliminating slag and dross, **Types of Gates**, Their applications. Design of gate, **Risers** : Function, factors involved in the design and their importance, Moulding of riser, Chevinrou's rule & Caine's method, Factors effecting riser efficiency, **Chills**, their use, simple Progressive and directional solidification, Fluidity – factors.
- 8. Defects in casting** : Moulding defects, - shifts, blow holes, pin holes, shrinkage cavity, porosity, metal penetration and rough surface, Scabs, hot tears, cold shuts and misrun, warpage of casting, swell, slag holes.

REFERENCE BOOKS

1. Principles of metal casting -by Heine and Rosential
2. Foundry Technology -by P.K Jain
3. Foundry Technology -by M. Lalkhanna Publishers
4. Modern foundry Practice -by Hayward

HEAT TREATMENT TECHNOLOGY

Subject Title : Heat Treatment Technology.
Subject Code : Met – 404
Periods/Week : 05
Periods/Semester : 75

TIME SCHEDULE

S.No	Major Topics	Periods	Weightage of Marks	Port Type	Essay Type
1.	Heat treatment of plain carbon steels	13	16	2	1
2.	Hardenability	08	13	1	1
3.	Grain size	08	13	1	1
4.	Alloy steels and their Heat Treatment	13	16	2	1
5.	Special Heat Treatment Techniques & defects	18	26	2	2
6.	Heat Treatment of Non-ferrous Metals	08	13	1	1
7.	Heat treatment Furnaces & atmospheres	07	13	1	1
	Total	75	110	10	8

OBJECTIVES

On the completion of the subject, the student should be able to understand,

1.0 Heat treatment of steels:

- 1.1 Define Heat Treatment.
- 1.2 State the objectives & purposes of Heat Treatment.
- 1.3 List the Heat treatment processes.
- 1.4 Know about the phase transformations on heating of steels.
- 1.5 Know about the decomposition of austenite on cooling.
- 1.6 Define isothermal transformation.
- 1.7 Explain the construction of Time Temperature Transformation Diagrams.
- 1.8 List out the factors affecting position of TTT curve.
- 1.9 Define Critical Cooling rate.
- 1.10 Explain the superimposition of continuous cooling curves.
- 1.11 Define a) Pearlite b) Bainite & c) Martensite
- 1.12 Explain the mechanism of austenite to
 - a. Pearlitic transformation
 - b. Bainitic transformation
 - c. Martensitic transformation.
- 1.13 State the effect of carbon content on Maximum hardness of steel.
- 1.14 Define and state the purpose of
 - a) Annealing
 - b) Normalizing
 - c) Hardening
- 1.15 Mention the Annealing, Normalizing and Hardening temperatures of eutectoid, hypo eutectoid, hyper eutectoid steels.
- 1.16 Explain a) Annealing

- b) Normalizing
- c) Hardening processes.

- 1.17 List out the types of annealing.
- 1.18 Draw the microstructures at various temperatures of annealing
- 1.19 Define & state the purpose of spheroidizing annealing
- 1.20 Explain the spheroidizing process.
- 1.21 Draw the spheroidized structure.
- 1.22 Draw the normalized microstructure.
- 1.23 Compare annealing & normalizing.
- 1.24 Mention the stages of quenching.
- 1.25 Draw the hardened microstructure.
- 1.26 Define & state the purpose of Tempering
- 1.27 Explain the Tempering process.
- 1.28 Describe the theory of Tempering. .
- 1.29 State the effect of Tempering on microstructure and mechanical properties.
- 1.30 Describe the types of tempering
- 1.31 Define retained austenite.
- 1.32 Define Temper Embrittlement and state the causes and remedies..

2.0 Hardenability:

- 2.1 Define hardenability
- 2.2 Differentiate Hardness and Hardenability.
- 2.3 State different Quenching Media.
- 2.4 Define the cooling power of Quenching Media.
- 2.5 List out merits & demerits of each quenching medium.
- 2.6 Define critical diameter & ideal critical diameter.
- 2.7 Draw the relationship between critical diameter & ideal critical diameter.
- 2.8 Determine the relationship between ideal critical diameter, chemical composition & hardenability.
- 2.9 Explain the Jominey end – quench test .
- 2.10 State the use of Jominey end quench test

3.0 Grain size

- 3.1 Define grain size.
- 3.2 Determine the grain size by carburising method.
- 3.3 Determine the grain size by ASTM comparative Method..
- 3.4 State the measurement of Austenite grain size by Heyn's intercept method and Jefferies planimetric method.

4.0 Heat Treatment of Alloy steels:

- 4.1 State the purpose of alloying.
- 4.2 Mention the effect of alloying elements on the Fe-Carbide diagram & hardenability.
- 4.3 Classify the alloying elements which tend to
 - a. form carbides.
 - b. graphitise the carbides
 - c. stabilize the austenite
 - d. stabilise the Ferrite
- 4.4 Give the composition, properties & applications of
 - a. Nickel steels.

- b. Chromium steels
- c. Manganese steels

4.5 Define stainless steels.

4.6 Classify the stainless steels.

4.7 State the composition, properties and applications of

- a. Ferritic
- b. Austenitic
- c. Martensitic stainless steels.

4.8 State the heat treatment process for ferritic, austenitic and martensitic stainless steels.

4.9 Know about sensitisation & stabilisation.

4.10 List the causes and remedies of sensitisation.

4.11 Know about composition, properties and applications of Maraging steels.

4.12 Define tool steels.

4.13 Give the composition of

- a) Water hardening steels
- b) High-speed tool steels.

4.14 List the properties of high-speed tool steels.

4.15 Give the heat treatment procedure for tool steels.

4.16 Explain the heat treatment cycle for high-speed steels.

4.17 Define secondary hardening.

4.18 Know the Special cutting materials.

4.19 Know the chemical composition & properties of stellite.

4.20 Know the chemical composition, microstructure & properties of cemented carbides.

5.0 Special heat treatment techniques:

5.1 Define case hardening.

5.2 Know the case hardening techniques.

5.3 Define

- a) carburising
- b) Nitriding
- c) Cyaniding
- d) Flame Hardening
- e) Induction Hardening

5.4 State the types of carburising Techniques.

5.5 Explain

- a) Packcarburising,
- b) Liquidcarburising
- c) Gas carburising.

5.6 Enumerate the advantages & disadvantages of carburising.

5.7 List the applications of carburised steels

5.8 Draw the microstructure of carburised steel.

5.9 Explain the post carburising heat treatment.

5.10 Explain the nitriding process.

5.11 Know the effect of nitriding on properties of steels.

5.12 State the applications of nitriding.

5.13 Know about white layer.

5.14 Explain the cyaniding process.

5.15 Understand the composition of cyanide bath.

5.16 Enumerate advantages of cyaniding.

5.17 Explain the flame hardening process.

- 5.18 Explain the induction hardening process.
- 5.19 Define Austempering&Martempering
- 5.20 Explain the austempering process.
- 5.21 Mention the effect of austempering on properties of steels.
- 5.22 Explain the martempering process.
- 5.23 Mention the effect of martempering on properties of steel.
- 5.24 Know about defects in heat treated products.
- 5.25 Mention the causes and remedies of low hardness, soft spots, oxidation, decarburisation, overheating, burning, quench cracks, distortion and warping.
- 5.26 Know about Widmanstatten structure.

6.0 Heat treatment of Non-ferrous Metals:

- 6.1 Know about the Heat treatment of Al-Cu alloy.
- 6.2 Explain solution treatment with the help of Al – Cu phase diagram
- 6.3 Explain precipitation hardening.
- 6.4 Explain the theory of Age-hardening.
- 6.5 List the Al – alloys respond to precipitation hardening
- 6.6 State the Heat treatment process for Brass and Bronzes

7.0 Heat treatment furnaces & atmospheres

- 7.1 Importance of furnaces.
- 7.2 Types of furnaces.
- 7.3 Distinguish between heat treatment and processing furnaces.
- 7.4 List out the various types of heat treatment furnaces.
- 7.5 Classification of heat treatment furnaces.
- 7.6 Differentiate furnaces based on their fuels used.
- 7.7 Classify the heat-treating furnaces based on their design and use.
- 7.8 Explain the working principle of the following furnaces with a neat sketch.
 - a. Muffle Furnace b.Salt bath c. Bogie d. Pit e. Rotary hearth
- 7.9 Explain about furnace atmospheres.
- 7.10 Define the controlled atmosphere.
- 7.11 Know about the necessity of maintaining controlled atmosphere.
- 7.12 Know about the exothermic and endothermic atmosphere.
- 7.13 State the methods of controlling furnace atmosphere

COURSE CONTENTS:

1.0 Heat Treatment of Plain Carbon Steels :

Introduction, Transformation of Austenite to pearlite, bainite, martensite, construction of TTT curves and their applications, types of heat treatment processes- Annealing, Normalising, Hardening and Tempering, Temper embrittlement.

2.0 Hardenability :

Definition, difference between hardness and harden ability, critical & ideal critical diameter, calculation of ideal critical diameter, jominey end quench test process and its uses,.

3.0 Grain Size:

Effect of grain size on properties of steel, Grain size determination by.Carburising method, ASTM Comparative method heyn's intercept method, Jefferies planimetric method,.

4.0 Alloy Steels & their Heat treatment:

Definition, Purpose of alloying, Effect of alloying elements on Fe – C diagram. Classification of alloying elements, Nickel steels, Manganese steels, Chromium steels, Stainless steels, Tool steels heat treatment, properties and uses. Maraging steels.

5.0 Special heat – treatment techniques and defects in heat treated products :Introduction, Chemical heat treatments -Carburising, Nitriding, Cyaniding,. Surface hardening treatments-Flame and Induction hardening. Austempering, Martempering and sub-zero treatment.Defects in the Heat treatment.

6.0 Heat treatment of Non-ferrous Metals:

Introduction, Precipitation hardening of Al-Cu alloys, Heat treatment of Brasses and Bronze.

7.0 Furnaces:

Importance of furnaces, Types of furnaces, List out the various types of heat treatment furnaces, Classification of heat treatment furnaces, working principle of Muffle furnace, Induction Furnace, Salt bath furnace, Bogie furnace, Pit furnace, Rotary hearth furnace, furnace atmospheres

REFERENCE BOOKS:

1. Heat Treatment Principles and Techniques - by T.V. RajanSarma, AshokSharma.
2. Engineering metallurgy Part I - by Raymond Higgins
3. Metallurgy for Engineers - by E.C. Rollason ELBS.
4. Physical metallurgy and Heat Treatment- byLakhtin
5. Introduction to physical metallurgy - Sydney H. Avener
6. Physical metallurgy for engineers - Clark&Warney
7. Materials science and Metallurgy - kodigere

STEEL MAKING

Subject Title	:	Steel Making
Subject Code	:	Met-405
Periods/Week	:	05
Periods per Semester	:	75

TIME SCHEDULE

S.No	Major Topics	Periods	Weightage of Marks	Short Type	Essay Type
1.	Introduction of steel making	9	13	1	1
2.	Open –hearth process	8	13	1	1
3.	Oxygen steel making	12	16	2	1
4.	Electric furnaces	12	16	2	1
5.	vacuum treatment of liquid steel	8	13	1	1
6.	Secondary steel making process	9	13	1	1
7.	Casting pit practice	9	13	1	1
8.	Ferro - Alloys	8	13	1	1
	Total	75	110	10	8

OBJECTIVES

1.0 Introduction of steel making.

- 1.1 History Of Steel Making: Cementation and crucible processes.
- 1.2 Know the wrought iron making process.
- 1.3 State the principle of Steel making.
- 1.4 Chemistry of Steel Making processes, Theories of slag. Oxidation of Si, Mn and C.
- 1.5 List the steel making processes.
- 1.6 List out the raw materials required for steel making.
- 1.7 State the principle of Bessemer process.
- 1.8 Explain basic Bessemer process -fore blow & after blow
- 1.9 Differentiate between acid bessemer and Basic bessemer processes.
- 1.10 State the limitations of Bessemer process.
- 1.11 Define the mixer.
- 1.12 Classify the mixers.
- 1.13 Differentiate the Active mixer & inactive mixer.

2.0 Open hearth process:

- 2.1 State the general principles.
- 2.2 Classify the open-hearth process.
- 2.3 Explain construction & lining of basic open-hearth furnace
 - i) Hearth and walls
 - ii) Roof
 - iii) Ports
 - iv) Slag pockets.
- 2.4 Explain the chemistry of the Basic open hearth process.
- 2.5 Know the types of steels produced.
- 2.6 State the advantages of Open Hearth Process as compared to Bessemer process.
- 2.7 Explain recent trends in open hearth process.
 - i) Ajax
 - ii) Tandem
 - iii) tilting open hearth
 - iv) Twin hearth

3.0 Oxygen steel making:

- 3.1 State the principles of Oxygen Steel making Process.
- 3.2 List Oxygen Steel making processes
- 3.3 Advantages of using pure Oxygen in Steel making.
- 3.4 State the Raw materials for L.D. Process
- 3.5 Explain the constructional details of converter & design of the lance.
- 3.6 Know the lining of the converter.
- 3.7 Explain the operation of L.D. Process with chemical reactions.
- 3.8 Understand the sequence of elimination of impurities
- 3.9 Appreciate the advantages & uses of L.D. process.
- 3.10 Understand dephosphorization, desulphurization and deoxidation in L.D
- 3.11 Explain stainless steel making process by L.D.
- 3.12 Understand the developments in L.D.process - LD-AC, LAM process, Kaldo, Rotor and OBM.

4.0 Electric Furnaces:

- 4.1 Classify the electric furnaces.
- 4.2 State the principle of Arc furnace.
- 4.3 List the raw materials.
- 4.4 State the sequence of the charging.
- 4.5 Know the electrode material.
- 4.6 Explain the construction and lining details of furnace.
- 4.7 Explain the melting practice for the production of carbon steels
- 4.8 Define carbide slag.
- 4.10 State the importance of carbide slag.
- 4.11 Appreciate advantages & disadvantages of Arc furnace.
- 4.12 Know the use of gaseous oxygen in Electric Arc furnace
- 4.13 Explain stainless steel making by electric arc furnace(Rust less Process)
- 4.14 State the principle of induction furnace.
- 4.15 Explain the melting practice in Induction furnace
- 4.16 Appreciate the advantages of induction furnace

5.0 vacuum treatment of liquid steel:

- 5.1 Know the gasses and inclusions in liquid steel
- 5.2 State the objectives of degassing
- 5.3 Classify the degassing processes.
- 5.4 Explain the ladle degassing, steam degassing, circulation degassing (R-H &D – H process)

6.0 Secondary steel making processes:

- 6.1 Need for production of high quality steels
- 6.2 State the objectives of secondary steel making.
- 6.3 Classification of Secondary steel making processes.
- 6.4 Explain Furnace based processes-A.O.D process.
- 6.5 Explain Ladle based processes-Ladle furnace..
- 6.6 Explain Remelting processes-E.S.R. and V.A.R.
- 6.7 Recent trends in secondary steelmaking processes.

7.0 Casting pit practice:

- 7.1 Classify the ingot moulds.
- 7.2 Know the ingot mould material.
- 7.3 List the Methods of teeming.
- 7.4 Explain various methods of teeming.
- 7.5 Classify the steels basing on gas evolution – killed, semi killed, rimmed & capped steels
- 7.6 List the ingot defects.
- 7.7 Explain various ingot defects with remedial measures.
- 7.8 Define the continuous casting.
- 7.9 Appreciate the advantages of continuous casting.
- 7.10 State the Principle of Continuous Casting
- 7.11 State junghan's principle
- 7.12 Classify the continuous casting machines.
- 7.13 Explain the vertical mold – horizontal discharge type Machine.
- 7.14 Explain the curved mold continuous casting machine and state its advantages
- 7.15 List the problems in the production of ingots by CCM.

8.0 Ferro alloys:

- 8.1 Define the term Ferro-alloy
- 8.2 State the types of Ferro alloys
- 8.3 State the purpose of using Ferro-alloys
- 8.4 Explain manufacturing process of Ferro-silicon
- 8.5 Identify the applications of Ferro-silicon in iron and steel industry

COURSE CONTENTS:

1.0 Introduction of steel making :

Wrought Iron, Bessemer Process, Mixers, Raw Materials, Chemistry of Steel Making, Acid and Basic steel Making.

2.0 Open – Hearth Process:

General principles, Regeneration principle, Classification, Basic open Hearth process, construction, Lining, operation Reactions, Tilting O.H. Process, Twin hearth, Ajax, Tandem furnace

3.0 Oxygen Steel Making:

L-D process:

Principles, Raw Materials, Lining of the converter, Blow period, lance, carbon steel Making; stainless steel Making, Advantages and uses. Developments in LD – LDAC – LAM – KALDO – ROTOR.

4.0 Electric Furnaces:

Principles of arc Furnace, classification, Raw materials sequence of charging, Electrode Material, construction of arc furnace, Melting practice, single and double slag practice carbide slag, Use of oxygen lancing, Advantages and disadvantages, Melting practice in Induction furnace, Advantages of induction Furnace.

5.0 VACCUM TREATMENT OF LIQUID STEEL

Gases dissolved in liquid steel, Function of degassing plant Ladle degassing, stream degassing, circulation degassing, (R.H&D.H process)

6.0 SECONDARY STEEL MAKING PROCESS

AOD process, Ladle furnace, ESR process, vaccum Arc melting,

7.0 CASTING PIT PRACTICE

Classification of Ingot moulds, Mould materials, methods of teeming, killed, semi-killed, Rimmed, capped steels, Ingot defects. Continuous casing of steel: Principle, Advantages, Junghan's principle, Curved type; Vertical type – Horizontal discharge CCM

8.0 FERRO – ALLOYS:- Definition, types, purpose, manufacture of ferro – silicon, its applications

Reference Books :

- | | |
|---|-------------------------|
| 1. Introduction of modern steel making -- | R.H. Tupkary |
| 2. Manufacture of iron and steel Vol.II -- | G.R.Bashforth |
| 3. Elements of metallurgy -- | Dr. Swaroop |
| 4. Iron and steel making theory and practice -- | AhindraGhosh&Chatterjee |

MATERIAL TESTING LAB

Subject Title : **Material Testing Lab**
Subject Code : **Met-406**
Periods/Week : **06**
Periods/Semester : **90**

TIME SCHEDULE

Sl.No	Experiment Title	No. of Periods
1	Tensile test	24
2	Brinell hardness test	15
3	Rockwell hardness test	15
4	Rockwell superficial hardness test	18
5	Impact test	18
Total periods		90

OBJECTIVES

Up on the completion of the course the student shall be able to:

1. Define the various properties of materials such as: yield stress, Ultimate stress, percentage elongation, elastic limit ,breaking stress ,percentage reduction in area
2. Define brinell hardness number of given material. Conduct experiments on ferrous and non ferrous materials by using brinells hardness tester
3. Conduct experiments on ferrous and non ferrous materials by using Rockwell hardness tester
4. Conduct experiments on given thin materials by using Rockwell superficial hardness tester
5. Perform tests to determine the impact strength by using izod and charpy test specimens

Key competencies to be achieved by the student

1. Tensile test	<ol style="list-style-type: none">1. Fix specimen in the jaws of the machine2. Fit strain gauge to the specimen3. Apply load gradually on the specimen4. Record load, elongation, diameter without error5. Plot graph stress vs strain
2. Brinell hardness test	<ol style="list-style-type: none">1. Place the specimen on the machine at correct location2. Make indent on the specimen properly3. Measure diameter of indentation and calculate hardness number
3. Rockwell hardness test	<ol style="list-style-type: none">1. Place the specimen on the machine at correct location2. Identify suitable indenter for the specimen3. Make indent on the specimen properly4. Measure diameter of indentation and Calculate hardness number
4. Rockwell superficial hardness test	<ol style="list-style-type: none">1. Place the specimen on the machine at correct location2. Identify suitable indenter for the specimen3. Make indent on the specimen properly4. Measure diameter of indentation and Calculate hardness number
5. Impact test	<ol style="list-style-type: none">1. Prepare specimen by making V notch at the required height2. Fix specimen on the machine3. Release load to hit the specimen precautionous and record load

COURSE CONTENT

1. Determination of yield strength, ultimate strength, percentage reduction in area, percentage elongation, elastic limit, breaking stress, stress-strain curve by using UTM
2. Determine the brinells hardness number of ferrous and non ferrous materials by using brinells hardness tester.
3. Determine the brinells hardness number of ferrous and non ferrous materials by using Rockwell hardness tester.
4. Determine the hardness of thin specimens such as raser blades, hacksaw blades, thin sheets using Rockwellsuperficial hardness tester.
5. Determination of impact strength of the material using Izod and Charpy's tests.

HEAT TREATMENT LAB

Subject Title	:	Heat Treatment lab
Subject Code	:	Met – 407
Total No. of Periods	:	06
Total Periods Per Semester	:	90

TIME SCHEDULE

Sl.No.	Experiment Title	No. of periods
1	Annealing of steels	12
2	Hardening of steels	12
3	Normalizing of steels	18
4	Tempering of steels	12
5	Jominey-end quench test	18
6	Optical Pyrometer	18
		90

OBJECTIVES

Up on Completion of the course the student shall be able to:

1.0 Annealing of steels:

- 1.1 Define Annealing
- 1.2 Types of annealing process
- 1.3 Working of Muffle furnace
- 1.4 Handling of apparatus
- 1.5 Observing and manipulating of furnace temperature
- 1.6 Cooling of specimen in the furnace
- 1.8 Microstructure analysis of annealed specimen
- 1.9 Draw the microstructure of annealed steel sample

2.0 Hardening of steels:

- 2.1 Define hardening
- 2.2 List of quenching media
- 2.3 Identify the parts of muffle furnace
- 2.4 Calibrate the temperature of the furnace
- 2.5 Handling the specimen before quenching by using fixtures
- 2.6 Analysis of Microstructures of hardened specimens by using different quenching media
- 2.7 Observe the phases of microstructures
- 2.8 Draw the microstructure
- 2.9 Recording the hardness values before hardening and after hardening
- 2.10 Explain the need and scope of the Experiment in industry

3.0 Normalizing of steels

- 3.1 Define normalizing
- 3.2 Need of normalizing of annealed specimens
- 3.3 Recording of normalizing temperature
- 3.5 Draw the microstructure of normalized steel

3.5 Identify the phases present in normalized steel sample microstructure

4.0 Tempering of steels

- 4.1 Define tempering
- 4.2 Need of tempering heat treatment for hardened steels
- 4.3 Types of tempering processes
- 4.4 Draw the microstructures of tempered steel specimens
- 4.5 Study the structural changes during tempering process

5.0 Jominey-end quench test

- 5.1 Define hardenability
- 5.2 Specimen dimensions of sample used in jominey end quench test
- 5.3 To know the critical diameter
- 5.4 Handling of equipment
- 5.5 Maintaining the constant pressure of water through an orifice
- 5.6 To maintain temperature of water
- 5.7 To know maintaining of distance between orifice and end of steel bar
- 5.8 Plot the hardenability curve

6.0 Optical Pyrometer

- 6.1 Types of optical pyrometers
- 6.2 Principle of optical pyrometer
- 6.3 Working of optical pyrometer
- 6.4 Handling of equipment
- 6.5 Recording of furnace temperature using optical pyrometer.

1. Annealing	<ol style="list-style-type: none">1. Calibration of furnace temperature2. Load the sample3. Cooling the sample in furnace atmosphere
2. Hardening	<ol style="list-style-type: none">1. Selecting of quenching media2. Soaking of sample in furnace temperature3. Holding of quenching media
3. Normalizing	<ol style="list-style-type: none">1. Recording of normalized temperature2. Soaking of sample in furnace3. Cooling of sample in open air
4. Tempering	<ol style="list-style-type: none">1. Selecting of hardened sample2. Soaking of sample in the furnace3. Air cooling of sample
5. Jominey-end quench test	<ol style="list-style-type: none">1. Hardening of the sample2. Quenching of sample by using fixtures3. Maintain the water temperature and pressure
6. Optical Pyrometer	<ol style="list-style-type: none">1. Principle of optical pyrometer2. Recording of furnace temperature

Communication Skills Lab Practice

(Common to all Branches)

Subject Title : **Communication Skills Lab Practice**
Subject Code : **Met – 408**
Total No. of Periods : **06**
Total Periods Per Semester : **90**

Introduction :

In the context of globalization , competence in speaking skills is the need of the hour The gap between the needs of the industry and the curriculum can be bridged by enabling the students to hone their speaking and listening skills. This course aims at providing opportunities for practicing speaking.

Time Schedule

Sno.	Topic	Periods	Weightage of marks (End Exam)	Sessional marks	Total
1	Listening I	3	10	10	20
2	Listening II	3			
3	Introducing oneself	3	50	30	80
4	Describing objects	3			
5	Describing events	3			
6	Reporting past incidents	3			
7	Speaking from observation / reading	3			
8	JAM	6			
9	Group discussion	6			
10	Mock interviews	6			
11	Making presentations	6	60	40	100
		45			

Objectives :

On completion of the course the students will be able to

- Strengthen their listening skills
- Strengthen their speaking skills

Competencies and key competencies to be achieved by the student

Topic	Teacher's input/ methodology	Students competence
Listening I Listening II	Pre- Listening –eliciting, pictures While - Listening Post –Listening –project , writing	Identifying the main idea, Identifying specific details, Identifying parallel and contradictory ideas Drawing inferences, Reasoning
Introducing oneself	Kinds of introduction --official/ personal, dynamic vocabulary, Body language, Model introduction, Use of line ups	Use of simple present tense, Sequencing, Appropriate vocabulary
Reporting incidents	Group work /pair work, Elicit, Use of past tense, Student presentations	Use of past tense, Relevant vocabulary
Describing objects	Vocabulary , Use of adjectives, Games—I spy, Group presentations	Use of adjectives, Dimensions,shapes Compare and contrast, Sequence
Describing events	Group work/pair work Use of appropriate tense	Use of appropriate tense, Sequencing

Reporting past incidents	Use of past tense, Vocabulary Student presentations	Use of past tense , sequencing
Speaking from observation/rea ding	Group work/pair work, Reading techniques ,	Use of past tense, Summarising , evaluating, comprehension
JAM	Effective techniques , Good beginning , conclusion, tips, Use of line ups	Vocabulary, Sequencing, Fluency, Thinking spontaneously
Group discussion	Expressing opinion, body language,	Expressing opinion, agree/ disagree, fluency,Persuasive and leadership skills
Mock interview	FAQs , body language	Role play, body language,
Making presentations	Student presentations	Using charts , pictures, interpreting data, sequencing,PPTs

Communicative methodology (CLT) should be used to create an interactive class. Apart from the suggestions given teachers are free to innovate to use any activity to improve the language competence of students . Attention can also be given to improve the accent and intonation of students.

Note:

* This subject is a theory subject.

** The workload should be calculated as theory workload.

***Examinations in the subject will be treated as a practical one.

FOUNDRY LAB

Subject title : Foundry Lab
Subject Code : Met- 409
Periods / week : 03
Periods / semester : 45

TIME SCHEDULE

S. No.	Major Components	Periods
1.	Standard sand specimen	03
2.	Green Compression & Green Shear Dry Compression & Dry Shear strength	06
3.	AFS Grain Fineness number	06
4.	Hardness of the moulding sand	06
5.	Moisture content determination	06
6.	Preparation of mould cavity	12
7.	Preparation of sand core and assembling in the cavity.	06
Total No. Periods		45

OBJECTIVES

Up on Completion of the course the student shall be able to:

1.0 Standard sand specimen

- 1.1 Define the term moulding sand.
- 1.2 List the constituents of moulding sand.
- 1.3 State the properties of a good moulding sand
- 1.4 Explain the function of sand rammer
- 1.5 prepare a suitable sand mixture
- 1.6 Handle the apparatus
- 1.7 Manipulate the apparatus
- 1.8 Perform the precise operations to prepare a standard sand specimen
- 1.9 List the Precautions and safety procedures
- 1.10 Explain the need and scope of the Experiment in industry

2.0 Green Compression & Green Shear and Dry Compression & Dry Shear strength

- 2.1 Explain the properties of moulding sand
- 2.2 Explain the importance of green & dry strength of the moulding sand.
- 2.3 Differentiate between compressive loading and shear loading
- 2.4 Prepare a suitable sand mixture
- 2.5 Identify the parts of a universal sand testing machine
- 2.6 Handle the apparatus
- 2.7 Manipulate the apparatus
- 2.8 Perform the precise operations to determine the compression and shear strength of a sand mixture
- 2.10 Record various observations
- 2.11 State the effect of temperature on the strength.

- 2.12 Draw the graph between the temperature and strength.
- 2.13 Explain the need and scope of the Experiment
- 3.0 AFS Grain Fineness number**
 - 3.1 Explain the importance of size and shape of sand grains
 - 3.2 State the effect of size and shape of sand grains on the properties of sand mould.
 - 3.3 Identify various parts of sieve shaker.
 - 3.4 Arrange the set sieves in the order
 - 3.5 Handle the apparatus
 - 3.6 Manipulate the apparatus
 - 3.7 Perform precise operations on sieve shaker to record various parameters
 - 3.8 Determine the AFS Grain Fineness Number from the observations.
 - 3.9 Explain the need and scope of the Experiment
- 4.0 Hardness of the moulding sand.**
 - 4.1 Explain the importance of sand hardness
 - 4.2 Identify the parts hardness tester.
 - 4.3 Handle the apparatus
 - 4.4 Manipulate the apparatus
 - 4.5 Perform precise operation of hardness tester on sand specimen and mould cavity and record the observations
 - 4.6 Explain the need and scope of the Experiment
- 5.0 Moisture content determination**
 - 5.1 State the importance of moisture content in the sand mix.
 - 5.2 Explain the methods of determination of moisture content
 - 5.3 State the principle on which rapid moisture teller works
 - 5.4 Handle the apparatus
 - 5.5 Manipulate the apparatus
 - 5.6 Perform precise operations on rapid moisture teller
 - 5.7 Observe and record the readings
 - 5.8 Explain the need and scope of the Experiment
- 6.0 Preparation of mold cavity**
 - 6.1 Define pattern and List different patterns
 - 6.2 List various hand moulding tools for preparation of mould cavity
 - 6.3 Prepare suitable sand mixture
 - 6.4 Explain the procedure for preparation of sand mould
 - 6.5 Handle the tools
 - 6.6 Manipulate the tools
 - 6.7 Prepare a precise mould cavity
 - 6.8 Explain the need of the experiment
- 7.0 Preparation of a sand core and assemble in the mold cavity**
 - 7.1 Define core and state the function of core
 - 7.2 List different types of cores
 - 7.3 State the ingredients of a core sand mixture
 - 7.4 Explain the procedure for preparation of sand core
 - 7.5 Handle the tools
 - 7.6 Manipulate the tools
 - 7.7 Prepare a precise sand core and assemble it in the mould cavity
 - 7.8 Explain the need of the experiment.

KEY competencies to be achieved by the student

Title of the experiment	Key competency
Standard sand specimen	<ol style="list-style-type: none"> 1. weighed quantities of ingredients of sand 2. Place the tube in the base of the rammer 3. observe whether the tip coincides with zero or not 4. measure the length of the specimen
Green Compression & Green Shear Dry Compression & Dry Shear strength	<ol style="list-style-type: none"> 1. identify the compressive & shear heads 2. Apply the load gradually 3. Record the reading carefully after specimen breaks
AFS Grain Fineness number	<ol style="list-style-type: none"> 1. Arrange the set of sieves in order 2. weigh the quantities of sand retained on the sieves after shaking 3. Tabulate the readings and calculate the fineness number
Hardness of the moulding sand	<ol style="list-style-type: none"> 1. Operate the tester 2. Apply load gradually 3. Observe and record the reading
Moisture content determination	<ol style="list-style-type: none"> 1. Operate the moisture teller 2. Add CaC₂ powder and shake vigorously 3. Observe and record the reading
Preparation of mould cavity	<ol style="list-style-type: none"> 1. Identify various tools 2. operate the tools precisely 3. with drawl of pattern 4. Cut the gates and runners 5. finish the cavity & close the boxes
Preparation of sand core	<ol style="list-style-type: none"> 1. Identify the tools required 2. operate the tools carefully 3. withdraw the finished core 4. Assemble the core in the cavity

COURSE CONTENT

1. Preparation of a standard sand specimen.
2. Determination of green compression, shear & Dry compression and shear strength of a given sand mixture by using universal sand testing machine
3. Determination of AFS Grain Fineness Number of given sand mixture by using a standard sieve shaker
4. Determination of hardness of the given sand mixture by using hardness tester
5. Determination of moisture content of the given sand mixture by using rapid moisture teller .
6. Preparation of a green sand mould cavity with the given pattern.
7. Preparation a sand core and assembly of the core in the mould cavity

C-16-V SEMESTER
SCHEME OF INSTRUCTION AND EXAMINATION
MET-501-INDUSTRIAL TRAINING

S No	Subject	Duration	Scheme of Examination			
			Nature	Item	Max. Marks	
1.	Practical training in a metallurgical Industry or allied Industry	6 Months	Viva Voce & Log book	<u>At the Industry</u>		
				1) First Assessment (At the end of 3 rd month)		100
				2) Second Assessment (At the end of 6 th month)		100
				<u>At the Institution</u>		
				4) Log Book		30
				5) Training Report		30
			6) Seminar on training	40		
Total for V semester					300	

1.The Industrial training shall carry 300 marks and pass marks is 50%. A candidate failing to secure the minimum marks should complete it at his own expenses.

2. During Industrial training the candidate shall put a minimum of 90% attendance.

OBJECTIVES

On completion of a spell of practical training in a chemical or allied industry, the student will be able to

1.0 Know the organizational set up from top executive to workmen level

- 1.1 Know the function of each department/section
- 1.2 Know the inter relationship among various department/sections

2.0 Know the various raw materials used as feed stock and chemical composition and their source.

- 2.1 Understand the various intermediates produced and their further processing and/or waste disposal.
- 2.2 Know the final products, its composition and its commercial importance's, uses and applications.

3.0 Understand the various stages involved in processing, sequential arrangement of different equipment.

- Draw the block flow diagram, detail flow diagram of each process after line tracing.
- 3.2 Understand the arrangement of various process equipment in systematic manner in a less possible area of site.

4.0 Know importance process variables required to be maintained in each process equipment of each unit like temperature, pressure.

- 4.1 Understand the effects of changes of process parameters.

5.0 Know the various operations in each process parameters.

- 5.1 Understand the unit operations principles
- 5.2 Apply unit operations theory learned at the Institution
- 5.3 Know the various processes
- 5.4 Identify the side reactions in each process plant.

6.0 Know the various analytical methods used in the quality control department

- 6.1 Understand the experimental methods to find out the compositions and physical properties of various raw materials, intermediates and final products
- 6.2 Operate various analytical instruments that are used in laboratory.

7.0 Know the trouble shooting in process operation

- 7.1 Know preventive precautions of the same for each equipment in each process
- 7.2 Startup and shut down procedures for the equipment and plant.

COURSE CONTENTS

1. Organizational set up
2. Raw materials, intermediates and end products
3. Process descriptions (Process flow diagrams and line tracing, detailed flow diagrams etc.)
4. Process parameters (such as temp., pressure, flow level etc.)
5. Operations and process in each process
6. Quality control of raw materials, intermediates and end products
7. Operational troubles and preventive measures
8. Process instrumentation
9. Safety aspects (personnel, equipment etc.)

INDUSTRIAL TRAINING SCHEME

V SEMESTER

1. A candidate shall be assessed twice in the spell of industrial training i.e. at the end of third month and finally before he/she completes the industrial training
2. The assessment shall be carried out by a committee comprising of
 - (a) A representative of the Industry where the candidate is undergoing training
 - (b) A staff member of the concerned section of the polytechnic.
3. The assessment at the end of the third month and the end of training shall each carry 100 marks for the progress made during the corresponding period of training.
4. The remaining 100 marks are allotted as follows:

For the training report (Record) 30 marks,
For maintenance of log book 30 marks
For seminar 40 marks.

These are to be evaluated at the institution at the end of training by a committee consisting following staff members
 - (1) Head of Section.
 - (2) External Examiner preferably from Industry
 - (3) Staff member who assessed the student during the Industrial Training.
5. The progress made during the end of assessment will be evaluated on the basis of the following parameters.

ASSESSMENT SCHEME

S. No.	Name of the Parameter	Max. Marks Allotted for each Parameter
1.	Attendance and punctuality	6
2.	Familiarity with Technical terms	8
3.	Familiarity with tools and material	8
4.	Attitude towards job	5
5.	Manual skills	6
6.	Application of knowledge	8
7.	Problem solving skills	8
8.	Comprehension and observation	7
9.	Safety & Environmental consciousness	5
10.	Human relations	6
11.	Ability to communicate	8
12.	Supervising ability	8
13.	General conduct during the period	7
14.	Maintenance of dairy	10
	Total:	100

C-16-VI SEMESTER
SCHEME OF INSTRUCTION AND EXAMINATION
MET-601-INDUSTRIAL TRAINING

S No	Subject	Duration	Scheme of Examination			
			Nature	Item	Max. Marks	
1.	Practical training in a metallurgical Industry or allied Industry	6 Months	Viva Voce & Log book	<u>At the Industry</u>		
				1) First Assessment (At the end of 3 rd month)		100
				2) Second Assessment (At the end of 6 th month)		100
				<u>At the Institution</u>		
				4) Log Book		30
				5) Training Report		30
			6) Seminar on training	40		
Total for V semester					300	

1.The Industrial training shall carry 300 marks and pass marks is 50%. A candidate failing to secure the minimum marks should complete it at his own expenses.

2. During Industrial training the candidate shall put a minimum of 90% attendance.

OBJECTIVES

On completion of a spell of practical training in a chemical or allied industry, the student will be able to

1.0 Know the organizational set up from top executive to workmen level

- 1.1 Know the function of each department/section
- 1.2 Know the inter relationship among various department/sections

2.0 Know the various raw materials used as feed stock and chemical composition and their source.

- 2.1 Understand the various intermediates produced and their further processing and/or waste disposal.
- 2.2 Know the final products, its composition and its commercial importance's, uses and applications.

3.0 Understand the various stages involved in processing, sequential arrangement of different equipment.

- Draw the block flow diagram, detail flow diagram of each process after line tracing.
- 3.2 Understand the arrangement of various process equipment in systematic manner in a less possible area of site.

4.0 Know importance process variables required to be maintained in each process equipment of each unit like temperature, pressure.

- 4.1 Understand the effects of changes of process parameters.

5.0 Know the various operations in each process parameters.

- 5.1 Understand the unit operations principles
- 5.2 Apply unit operations theory learned at the Institution
- 5.3 Know the various processes
- 5.4 Identify the side reactions in each process plant.

6.0 Know the various analytical methods used in the quality control department

- 6.1 Understand the experimental methods to find out the compositions and physical properties of various raw materials, intermediates and final products
- 6.2 Operate various analytical instruments that are used in laboratory.

7.0 Know the trouble shooting in process operation

- 7.1 Know preventive precautions of the same for each equipment in each process
- 7.2 Startup and shut down procedures for the equipment and plant.

COURSE CONTENTS

- 10. Organizational set up
- 11. Raw materials, intermediates and end products
- 12. Process descriptions (Process flow diagrams and line tracing, detailed flow diagrams etc.)
- 13. Process parameters (such as temp., pressure, flow level etc.)
- 14. Operations and process in each process
- 15. Quality control of raw materials, intermediates and end products
- 16. Operational troubles and preventive measures
- 17. Process instrumentation
- 18. Safety aspects (personnel, equipment etc.)

INDUSTRIAL TRAINING SCHEME

VI SEMESTER

6. A candidate shall be assessed twice in the spell of industrial training i.e. at the end of third month and finally before he/she completes the industrial training
7. The assessment shall be carried out by a committee comprising of
 - (c) A representative of the Industry where the candidate is undergoing training
 - (d) A staff member of the concerned section of the polytechnic.
8. The assessment at the end of the third month and the end of training shall each carry 100 marks for the progress made during the corresponding period of training.
9. The remaining 100 marks are allotted as follows:
 - For the training report (Record) 30 marks,
 - For maintenance of log book 30 marks
 - For seminar 40 marks.These are to be evaluated at the institution at the end of training by a committee consisting following staff members
 - (1) Head of Section.
 - (2) External Examiner preferably from Industry
 - (3) Staff member who assessed the student during the Industrial Training.
10. The progress made during the end of assessment will be evaluated on the basis of the following parameters.

ASSESSMENT SCHEME

S. No.	Name of the Parameter	Max. Marks Allotted for each Parameter
1.	Attendance and punctuality	6
2.	Familiarity with Technical terms	8
3.	Familiarity with tools and material	8
4.	Attitude towards job	5
5.	Manual skills	6
6.	Application of knowledge	8
7.	Problem solving skills	8
8.	Comprehension and observation	7
9.	Safety & Environmental consciousness	5
10.	Human relations	6
11.	Ability to communicate	8
12.	Supervising ability	8
13.	General conduct during the period	7
14.	Maintenance of dairy	10
	Total:	100

VII-SEM
(C-16)

Industrial Management & Smart Technologies

Subject Title	:	Industrial Management & Smart Technologies
Subject Code	:	MET-701
Periods/Week	:	5
Period/Semester	:	75

TIME SCHEDULE

S. No.	Major Topics	Periods	Weightage Of Marks	Short Answer Questions	Essay Type Questions
1.	Basics of Industrial Management	06	13	1	1
2.	Organisation structure & Organisational behaviour	10	18	1	1 ^{1/2}
3.	Production Management	10	18	1	1 ^{1/2}
4.	Materials Management	08	13	1	1
5	Maintenance management & Industrial Safety	08	13	1	1
6	Entrepreneurship Development	08	13	1	1
7	Total Quality Management	05	06	2	
8	Smart technologies	20	16	2	1
	Total	75	110	10	08

1. Basics of Industrial Management

On completion of the course the student will be able to

1.0 Understand the principles of management as applied to industry.

- 1.1 Define industry, commerce (Trade) and business.
- 1.2 Know the need for management.
- 1.3 Understand the evolution of management
- 1.4 Understand functions of Management.
- 1.5 Explain the principles of scientific management.
- 1.6 Explain the principles of management.
- 1.7 Differentiate between management and administration.
- 1.8 Understand the nature of management as a profession
- 1.9 Differentiate between supervisory, middle and Top level management
- 1.10 Explain the importance of managerial skills (Technical, Human, Conceptual)

2. Organisation Structure & organisational behaviour

Know types of ownerships, the organisation structure of an industry and the behaviour of an individual in an organisation.

- 2.1 Understand the philosophy and need of organisation structure of an industry.
- 2.2 Understand the line, staff and Functional organisations
- 2.3 Understand the Authority and Responsibility Relationships

- 2.4 Understand the differences between Delegation and decentralization
- 2.5 Explain the factors of effective organisation.
- 2.6 Outline the communication process
- 2.7 State motivation theories.
- 2.8 State Maslow's Hierarchy of needs.
- 2.9 List out different leadership models.
- 2.10 Explain the trait theory of leadership.
- 2.11 Explain behavioural theory of Leadership.
- 2.12 Explain the process of decision making.
- 2.13 Assessing Human resource requirements
- 2.14 Know the concept of Job analysis, Job description and specifications
- 2.15 Understand the process of recruitment, selection, training and development
- 2.16 Understand types of business ownerships
- 2.17 Differentiate between the business ownerships
- 2.18 Know the objectives of Employee participation
- 2.19 Understand the meaning and definition social responsibilities
- 2.20 Corporate social responsibility

3. Production management

Understand the different aspects of production management.

- 3.1 Identify the factors of Plant Location
- 3.2 Know the objectives of plant Layout
- 3.3 Understand the principles of plant Layouts
- 3.4 Explain the types of plant Layouts
- 3.5 Relate the production department with other departments.
- 3.6 State the need for planning and it's advantages.
- 3.7 Explain the stages of Production, planning and control.
- 3.8 Know the basic methods demand forecasting
- 3.9 Explain routing methods.
- 3.10 Explain scheduling methods.
- 3.11 Explain dispatching.
- 3.12 Explain Break Even Analysis
- 3.13 Define supply chain Management, competitive strategy, Supply chain strategy
- 3.14 Draw PERT/CPM networks.
- 3.15 Identify the critical path

4. Materials Management

Understand the role of materials management industries.

- 4.1 Explain the importance of materials management in Industry.
- 4.2 Know Functions of Materials Management
- 4.3 Derive expression for inventory control.
- 4.4 Explain ABC analysis.
- 4.5 Define safety stock.
- 4.6 Define reorder level.
- 4.7 Derive an expression for economic ordering quantity.
- 4.8 Know the functions of Stores Management,
- 4.9 Explain types of store layouts.
- 4.10 List out stores records.
- 4.11 Explain the Bin card.
- 4.12 Describe Cardex method.
- 4.13 Explain general purchasing procedures

- 4.14 Explain tendering, E-tendering and E-procurement procedures
- 4.15 List out purchase records.
- 4.16 Know the applications of RFID (Radio Frequency Identification Device)
- 4.17 Understand the applications of RFID in material management

5. Maintenance Management & Industrial Safety

Comprehend the Importance of Maintenance Management & Safety procedures

- 5.1 Explain the importance of maintenance management in Industry.
- 5.2 Know the Objectives of maintenance management
- 5.3 Know the activities of maintenance management
- 5.4 Understand the importance of Preventive maintenance
- 5.5 Understand the need for scheduled maintenance
- 5.6 Differentiate between scheduled and preventive maintenance
- 5.7 Know the principles of 5 s for good house keeping
- 5.8 Explain the importance of safety at Work place.
- 5.9 List out the important provisions related to safety.
- 5.10 Explain hazard and accident.
- 5.11 List out different hazards in the Industry.
- 5.12 Explain the causes of accidents.
- 5.13 Explain the direct and indirect cost of accidents.
- 5.14 Understand the types of emission from process Industries, their effects on environment and control
- 5.15 Understand the principles of solid waste management

6. Entrepreneurship Development.

Understand the role of entrepreneur in economic development and in improving the quality of life.

- 6.1 Define the word entrepreneur.
- 6.2 Explain the requirements of an entrepreneur.
- 6.3 Determine the role of entrepreneurs in promoting Small Scale Industries.
- 6.4 Describe the details of self-employment schemes.
- 6.5 Characteristic of successful entrepreneurs
- 6.6 Explain the method of site selection.
- 6.7 List the financial assistance programmes.
- 6.8 List out the organisations that help an entrepreneur
- 6.9 Know the use of EDP Programmes
- 6.10 Understand the concept of make in India, Zero defect and zero effect
- 6.11 Understand the importance for startups
- 6.12 Explain the conduct of demand surveys
- 6.13 Explain the conduct of a market survey
- 6.14 Evaluate Economic and Technical factors.
- 6.15 Prepare feasibility report study

7. Total Quality Management:

Understand the concepts adopted in total quality management

- 7.1 Explain the concept of quality.
- 7.2 List the quality systems and elements of quality systems.
- 7.3 State the principles of quality Assurance.
- 7.4 Understand the basic concepts of TQM

- 7.5 Know the Pillars of TQM
- 7.6 List the evolution of ISO standards.
- 7.7 Explain ISO standards and ISO 9000 series of quality systems.
- 7.8 List the beneficiaries of ISO 9000.
- 7.9 Explain the concepts of ISO 14000
- 7.10 Know the overview of PDCA cycle

8. Smart Technologies

8.1 Get an overview of IoT

- 8.1.1 Define the term IoT
- 8.1.2 Know how IoT work
- 8.1.3 List the key features of IoT
- 8.1.4 List the components of IoT : hardware, software, technology and protocols
- 8.1.5 List the advantages and disadvantages of IoT

8.2 IoT Applications

- 8.2.1 Smart Cities
- 8.2.2** Smart Energy and the Smart Grid
- 8.2.3** Smart Transportation and Mobility
- 8.2.4** Smart Home, Smart Buildings and Infrastructure
- 8.2.5** Smart Factory and Smart Manufacturing
- 8.2.6** Smart Health
- 8.2.7** Food and Water Tracking and Security
- 8.2.8** Social Networks and IoT

Course Content

1. Basics of Industrial Management

Introduction: Industry, Commerce and Business; Definition of management; Characteristics of management; Functions of management - Planning, Organizing, Staffing, Directing, Co-ordination, Controlling, Motivating, Communication, Decision Making; Principles of scientific management: – F.W.Taylor, Principles of Management: Henry Fayol; Administration and management; Nature of management; levels of management; managerial skills;

2. Organisation Structure & organisational behaviour

Organizing - Process of Organizing; Line/Staff and functional Organizations, Decentralization and Delegation, Effective Organizing; Communication, Motivational Theories; Leadership Models; Human resources development; Forms of Business ownerships: Types – Sole proprietorship, Partnership, Joint Stock Companies, Cooperative types of Organizations; Employee participation in management; Corporate Social responsibility;

3. Production management

Definition and importance; Plant location and layout; Types of production -job, batch and mass; production Planning and Control: Demand forecasting, routing, scheduling, dispatching and follow up; Break even analysis; Supply chain Management (Definition, Competitive strategy Vs Supply chain Strategy, Supply chain drivers); Project scheduling; Application of CPM and PERT techniques; simple numerical problems;

4. Materials Management

Materials in industry, Basic inventory control model, ABC Analysis, Safety stock, re-order level, Economic ordering quantity, Stores Management: Stores layout, stores equipment, Stores records, purchasing procedures, e-tendering, e-procurement; purchase records, Bin card, Cardex RFID (Radio Frequency Identification Device) application in materials management;

5. Maintenance Management & Industrial Safety

Objectives and importance of plant maintenance, Different types of maintenance, Nature of maintenance problems, Range of maintenance activities, Schedules of preventive maintenance, Advantages of preventive maintenance, 5 S principles; Importance of Safety at work places; Causes of accidents-psychological, physiological and other industrial hazards; Domino sequence; methods of promoting safe practices; Pollution control in process industries; Introductory concepts on Solid waste management (General introduction including definitions of solid waste including municipal, hospital and industrial solid waste, Waste reduction at source – municipal and industrial wastes)

6. Entrepreneurship Development.

Definition of Entrepreneur; Role of Entrepreneur; Concept of Make In India, ZERO defect, Zero Effect, Concept of Start-up Company, Entrepreneurial Development: Role of SSI, MSME, DICs, Entrepreneurial development schemes; Institutional support, financial assistance programmes; Market survey and Demand survey; Preparation of Feasibility study reports

7. Total Quality Management:

Total Quality Management (TQM)- Concept of quality discussed by B. Crosby W. Edward, Deming, Joseph M. Juran, Kooru Ishikawa, Genichi Taguchi, Shigco Shingo. Quality systems – Definitions of the terms used in quality systems like, quality policy, quality management, quality systems, Stages of development of ISO 9000 series , ISO-14000, Deming's PDCA Cycle (Plan, Do, Check and Action). Japanese Quality Management, culture, Kaizen Strategy (continuous improvement).

8. Smart Technologies :

Overview of IoT - Define IoT, how IoT work, key features of IoT, components of IoT : hardware, software, technology and protocols, advantages and disadvantages of IoT - IoT Applications - Smart Cities, Smart Energy and the Smart Grid, Smart Transportation and Mobility, Smart Home, Smart Buildings and Infrastructure, Smart Factory and Smart Manufacturing, Smart Health, Food and Water Tracking and Security, Participatory Sensing, Social Networks and IoT.

REFERENCE BOOKS

1. Industrial Engineering and Management -by O.P Khanna
2. Production Management- by Buffa.
3. Engineering Economics and Management Science - by Banga & Sharma.
4. Personnel Management by Flippo.
5. Production and Operations Management –S.N. Chary
6. Converging_Technologies_for_Smart_Environments_and_Integrated_Ecosystems_IERC_Book_Open_Access_2013 pages-54-76
7. Supply Chain Management –Sunil Chopra and Meindl, PHI publishers
8. 5 S made easy by David Visco

WELDING TECHNOLOGY

Subject title	:	Welding Technology
Subject Code	:	Met – 702
Periods/week	:	05
Periods per Semester	:	75

TIME SCHEDULE

S.No	Major Topics	Periods	Weightage of Marks	Short Type	Essay Type
1.	Basic concepts of Welding	8	13	1	1
2.	Oxy Acetylene welding	10	16	2	1
3.	Electric arc welding	10	16	2	1
4.	Gas shield Arc welding	10	13	1	1
5.	Special Welding processes	12	16	2	1
6	Soldering and Brazing	10	13	1	1
6.	Metallurgy of welds	10	13	1	1
7.	Inspection and testing of welds	5	10	-	1
	Total	75	110	10	8

OBJECTIVES

Upon the completion of the course the student will be able to:

1.0 Basic concepts of Welding.

- 1.1 State the various metal joining techniques.
- 1.2 Define welding.
- 1.3 Classify the welding processes – fusion and pressure welding processes
- 1.4 List the important welding process
- 1.5 Know the importance of welding as a fabrication technique.
- 1.6 Know the important welding terms.
(a) Weld bead, (b) Crater, (c) Filler weld, (d) Penetration, (e) Puddle, (f) Weld metal, (g) Weld pass
- 1.7 Know the different types of weld joints.
(a) Butt joint, (b) Lap joint, (c) Corner joint (d) T – joint (e) Edge joint
- 1.8 Know about the welding position.
(a) Flat, (b) Vertical, (c) Horizontal, (d) Overhead
- 1.9 Know the need for edge preparation in welding.
- 1.10 Mention the edge preparation Methods for butt joints.
(a) V – type, (b) Bevel, (c) U – type, (d) T – type
- 1.11 Know the safety practices in welding.

2.0 Oxy Acetylene welding.

- 2.1 List the steps involved in burning of Oxygen and acetylene.
- 2.2 Know the characteristics of oxy acetylene flame.
- 2.3 Describe the types of oxy acetylene flames and state their applications.
 - a. Carburizing
 - b. Oxidizing
 - c. Neutral

- 2.4 Mention the equipment for oxy acetylene welding.
- 2.5 Oxygen and acetylene cylinders
 - a. Regulators
 - b. Torches
 - c. Hose pipes
 - d. Control valves
- 2.6 Draw the sketch of oxyacetylene welding outfit and label the parts with colour codes.
- 2.7 Know the principles and operations of pressure reduction regulator, with line diagrams.
 - a. Single stage regulator
 - b. Two stage regulator
- 2.8 Explain the types of torches used in oxyacetylene welding with neat sketches.
 - a. Injector or low pressure torch
 - b. Equal pressure torch
- 2.9 Know the operation of an Oxyacetylene welding torch.
- 2.10 Know the precautions in storage of O₂ & C₂H cylinders
- 2.11 Explain the different welding techniques with neat sketches
 - a. Fore hand welding techniques
 - b. Back hand welding technique
- 2.12 Mention the advantages and applications of oxyacetylene welding.

3.0 Electric Arc welding.

- 3.1 Define Arc Column
- 3.2 Explain arc column theory with typical Arc welding circuit.
- 3.3 Know what are the major heat areas in the arc column
- 3.4 Define arc blow
- 3.5 Its causes and effect on welding
- 3.6 Mention the Methods of reducing the arc blow
- 3.7 Know about straight and reverse polarity – DCSP and DCRP and differentiate.
- 3.8 Mention arc welding machines based on source of electric power
 - a. AC welding machines
 - b. DC welding machines
- 3.9 Know about DAV, CAV and RAV.
- 3.10 List the major ways to control the fluctuating current in arc welding machine
- 3.11 State the advantages and limitations of
 - a. AC power supply
 - b. DC power supply
 - c. AC rectified power supply
- 3.12 Define welding crater.
- 3.13 Explain the metal transfer mechanism from electrode to the base metal with line sketches
- 3.14 Know what is burn off rate.
- 3.15 Mention the functions of flux coating on shield arc electrodes.
- 3.16 State the electrode classification as per ISI.
- 3.17 Define proper arc length
- 3.18 Mention the Methods of striking an arc
- 3.19 List the basic movements in manipulating the electrode and weld puddle
- 3.20 Know how the angle of electrode affects the weld bead.
- 3.21 State the advantages and applications of Arc Welding
- 3.22 Explain the principle of submerged arc welding

3.23 List the advantages and applications of submerged arc welding

4.0 Gas shield arc welding.

4.1 Introduction

4.2 List different inert gas welding processes.

(a) Tungsten inert gas welding (TIG) or GTAW.

(b) Metal inert gas welding (MIG processes)

4.3 Know how heat is liberated in TIG & MIG processes.

4.4 Know the difference in penetration in TIG & MIG.

4.5 State the functions shielding gases.

4.6 Explain the metal transfer mechanism in MIG with line sketches.

4.7 Know the Methods of striking an arc.

4.8 Write down the types of electrodes used

a) Tungsten b) Thoriated Tungsten

4.9 Know the power supplies for TIG & MIG.

4.10 State the equipment required for TIG & MIG welding

4.11 List the components of complete TIG & MIG out fits.

4.12 Explain the TIG welding technique.

4.13 Know how filler metal is added to the puddle

4.14 List the types of joint design used in TIG

4.15 State the advantages and application of TIG

4.16 Explain the MIG welding technique

4.17 List the types of joint design used in MIG

4.18 State the advantage and applications of MIG.

5.0 Special Welding processes.

5.1 List the special welding processes

a. Plasma arc welding

b. Resistance welding

c. Electro slag welding

d. Electron beam welding and laser beam welding

e. Thermit welding

5.2 Define plasma arc welding

5.3 Differentiate plasma gas and shielding gases.

5.4 Explain the plasma arc welding process(in brief)

5.5 State application and advantages of plasma arc welding

5.6 Define resistance welding

5.7 List the types of resistance welding

a. Spot welding

b. Seam welding

c. Projection welding

d. Butt welding

e. Flash welding

5.8 Explain in brief the above resistance welding processes and state its applications

5.9 Define electro slag welding

5.10 Explain in brief the electro slag welding process

5.11 State its application

5.12 Define electron beam welding

- 5.13 Explain in brief the electron beam welding
- 5.14 State the application of electron beam welding
- 5.15 Define Thermit welding
- 5.16 Explain in brief the Thermit welding process
- 5.17 State the applications of Thermit welding process
- 5.18 Define laser beam welding
- 5.19 Explain in brief the laser beam welding
- 5.20 State the application of laser beam welding

- 6.0 Metallurgy of welds**
- 6.1 Explain the metallurgical aspects of welding w.r.t weld puddle solidification
- 6.2 Explain the different heat affected zones in welding.
- 6.3 Draw the microstructure of a cross section of a weld joint and state the salient features
- 6.4 Define weldability
- 6.5 Explain the factors influencing weldability of Metals and Alloys.
- 6.6 State the necessity of post weld treatment
- 6.7 Explain in brief the post weld treatments

- 7.0 Inspection and testing of welds**
- 7.1 Define strength of a weld
- 7.2 List the various welding defects and state their remedies
 - a) Under cut & overlap
 - b) Gas porosity
 - c) Slag inclusion
 - d) Poor penetration
 - e) Centre line cracking
- 7.3 List the inspection and testing Methods of welds
- 7.4 Mention the purpose of each test

COURSE CONTENTS

1.0 Basic concepts of Welding.: Def. and importance Types of Metal joining techniques. Important Welding Terms. Edge Preparation and safety measures.

2.0 Oxyacetylene Welding : Introduction, Types and characteristics, Equipment used in oxy acetylene welding, pressure reduction regulators, Types of torches, different welding techniques, butt edge preparation, advantage and applications.

3.0 Electric Arc welding : Introduction, Arc column theory, Arc blow, power supplies, Types of welding machines, Welding crater, burn off rate, electrode classification, function of flux coating, Methods of striking an arc and Arc length electrode movements, advantages and applications, submerged arc welding.

4.0 Gas shield arc welding: Introduction, Types of processes - TIG & MIG. Mode of heat liberation. Types of electrodes in TIG & MIG. Metal transfer mechanism, Power Supplies, joint design in TIG & MIG processes. Advantages and application of TIG & MIG.

5.0 Other Welding processes : Introduction, List of special welding processes, plasma Arc welding Resistance welding, Electro slag welding, electron beam welding, thermit welding and laser beam welding.

6.0 Metallurgy of Welds : Introduction, metallurgical aspects of welding, weld ability, HAZ. Micro structures of welds. PWHT.

7.0 Inspection and testing of welds : Introduction, welding defects and remedies, Inspection and testing of welds.

REFERENCE BOOKS

- | | |
|---------------------------------------|------------------------|
| 1. Welding and welding technology | -by R.Little |
| 2. Welding Engineering | -by Agarwal&Tahilani |
| 3. Welding Technology | -by O.P.Khanna. |
| 4.Manufacturing technology | -by P.N.Rao |
| 5. Engineering metallurgy part I & II | -by Raymond A. Higgins |

METAL CASTING TECHNOLOGY

Subject Title	:	Metal Casting Technology
Subject Code	:	Met-703
Periods/Week	:	05
Periods per Semester	:	75

TIME SCHEDULE

S.No	Major Topics	Periods	Weightage of Marks	Short Type	Essay Type
1.	Introduction to Cast Irons	5	3	1	-
2.	Melting of Cast Irons	17	23	1	2
3.	Grey Iron	10	13	1	1
4.	Ductile Iron	10	13	1	1
5.	Malleable Iron	7	13	1	1
6.	Aluminium Foundry practice	7	13	1	1
7.	Copper Foundry Practice	7	13	1	1
8.	Steel Foundry Practice	6	6	2	-
9	Cleaning & Salvage of castings	6	13	1	1
	Total	75	110	10	8

OBJECTIVES

On the completion of the course the student will be able to:

1.0 Introduction to cast irons:

- 1.1 Define the terms cast iron, grey cast iron, white cast iron, chilled cast iron, malleable iron, nodular iron and compacted gray Iron
- 1.2 Express the composition of various cast irons
- 1.3 Define graphitisation.
- 1.4 State the factors effecting graphitisation.
- 1.5 Explain the solidification process of cast irons.
(a) Grey cast iron (b) White cast iron.
- 1.6 State the micro constituents present in cast irons.

2.0 Melting of cast irons

- 2.1 State the advantages & limitations of cupola.
- 2.2 Describe the mechanical structure of cupola with a sketch.
- 2.3 Explain various steps in the operation of cupola.
- 2.4 Describe various zones with chemical reactions.
- 2.5 Explain the principles of cupola operation.
- 2.6 Explain the melt control tests
(a) Chill test (b) Spiral fluidity test.
- 2.7 Calculate the molten metal analysis from the given charge analysis.
- 2.8 State the advantages and disadvantages of Induction furnace.
- 2.9 List out different types of Induction furnaces.
- 2.10 State the principle of Induction melting.
- 2.11 Explain the melting practice of cast iron in induction furnace.

3.0 Grey iron

- 3.1 State the properties and applications of Grey iron.
- 3.2 Classify the Grey irons.
- 3.3 State the effect of Silicon on the iron-iron carbide system.
- 3.4 Explain the chemical composition requirements of Grey iron.
- 3.5 Explain the solidification of Grey iron w.r.t Graphitisation.
- 3.6 List out the moulding methods used in Grey iron foundry.
- 3.7 Describe the additives required for ease of moulding.
- 3.8 State the foundry properties of Grey iron.
- 3.9 Calculate the pouring temperature and fluidity for a given composition of grey iron.
- 3.10 State different heat treatments of Grey iron.
- 3.11 Explain the effect of alloying elements on the properties and structure of grey iron.

4.0 Ductile iron

- 4.1 State the properties and uses of ductile iron.
- 4.2 Explain the composition requirements for ductile iron.
- 4.3 State the role of Mg.
- 4.4 Explain various Magnesium treatment methods.
- 4.5 Describe the metallurgical process control-
- 4.6 Fading of Mg. (b) Nodule size and count. (c) Carbide formation.
- 4.7 State the inoculation process.
- 4.8 State different heat treatments of ductile iron.
- 4.9 Draw the microstructure & identify the phases of ductile iron.

5.0 Malleable iron

- 5.1 State the properties & uses of malleable iron.
- 5.2 Mention the composition of white iron.
- 5.3 Draw the microstructure & identify of phases of white iron.
- 5.4 Explain the malleabilisation treatment of white iron for the production of malleable iron with reference to microstructural changes
- 5.5 List out the types of malleable iron.
- 5.6 Draw the microstructure of white & black heart malleable iron.
- 5.7 List the methods of producing black heart malleable iron.
- 5.8 Explain the method of producing black heart malleable iron

6.0 Aluminium foundry practice

- 6.1 List the uses of Aluminium castings.
- 6.2 State the different moulding methods used in an aluminium foundry.
- 6.3 Explain the melting procedure of aluminium alloys with respect to drossing, gas absorption, fluxing and flushing, grain refining and pouring temperature.
- 6.4 state suitable Gating ratios for aluminium alloys.
- 6.5 State the methods of Gating & Riser of aluminium alloys.
- 6.6 State the importance of multiple ingating.
- 6.7 State effect of unpressurised gating systems for aluminium castings
- 6.8 Explain the different casting defects in aluminium castings with remedial measures

7.0 Copper foundry practice

- 7.1 State the uses of copper alloy castings.

- 7.2 state the moulding procedures used in a copper alloy foundry
- 7.3 Explain the melting procedure of copper alloys with respect to deoxidation, oxygen and Hydrogen in copper melting, reaction of impurities, de-oxidation, control of gases and temperature control.
- 7.4 State the design of gating & Riser system in the case of copper alloy casting
- 7.5 Define the term reverse shrinkage
- 7.6 Explain the different casting defects in copper castings with remedial measures

8.0 Steel foundry practice

- 8.1 State the moulding processes used in steel foundry.
- 8.2 State the importance of Zircon sands.
- 8.3 State the importance of mould coating in steel foundry
- 8.4 State the effects of fluidity and shrinkage in the design of gates
- 8.5 State the purpose of a riser.
- 8.6 Give the effective feeding distance of a riser.
- 8.7 Explain the defects caused due to cores.
(a) Hot tear formation (b) metal penetration.

9.0 Cleaning & salvage of casting

- 9.1 List out the various cleaning operations.
- 9.2 Explain different techniques employed in removal of gates, risers.
- 9.3 Explain the various surface cleaning operations.
- 9.4 Differentiate between Tumbling & Blasting.
- 9.5 Describe the Trimming operations.
- 9.6 Mention the Finishing operations.
- 9.7 Define the term Salvage of castings.
- 9.8 List out various Salvage Techniques.
- 9.9 State different inspection methods

COURSE CONTENTS

- 1. Introduction to Cast irons:** Definition of Cast Iron – Types of Cast irons, Graphitisation, factors effecting, Solidification of cast irons-GI, W.I, and Micro constituents.
- 2. Melting of Cast irons:** Introduction, Cupola – Advantages & limitations, Mechanical structure, Steps in operation, Principles of cupola operation; melt control tests, induction melting, advantages & disadvantages, types, principle, operation.
- 3. Grey Iron:** Introduction, properties, uses, classification, Fe-C-Si system, chemical composition requirements, solidification w.r.t Graphitisation, method of moulding, additives, Gating & Feeding, foundry properties, heat treatment, alloy grey iron.
- 4. Ductile Iron:** Introduction, properties & uses, chemical composition requirements, role of Mg, Mg treatment methods, inoculation, metallurgical process control, heat treatment.
- 5. Malleable Iron:** Introduction, Properties & uses, composition of white iron, malleabilisation treatment, micro structures, methods of black heart malleable iron production.

6. Aluminium foundry practice: Introduction, properties & uses, melting procedure, moulding, gating and Riserling.

7. Copper foundry practice: Introduction, properties & uses, moulding, melting procedure, gating and Riserling.

8. Steel Foundry Practices; Introduction, moulding, zircon sands, gating and Riserling, common defects due to cores.

9. Cleaning & salvage of casting; Introduction, Cleaning operations, Salvage of casting, inspection.

REFERENCE BOOKS

- | | |
|-------------------------------|--------------------------------|
| 1. PRINCIPLE OF METAL CASTING | by HEINE AND ROSENTAL |
| 2. FOUNDRY TECHNOLOGY | by P.L. JAIN |
| 3. Foundry technology | by M.Lal, Khanna Publications. |
| 4. Foundry technology | by N.SRINIVAS. |

MECHANICAL METALLURGY

Subject Title : Mechanical Metallurgy
Subject Code : Met – 704
Periods/week : 05
Periods/Semester : 75

TIME SHEDULE

S.No	Major Topics	Periods	Weightage of Marks	Short Questions	Essay Questions
1.	Plastic deformation of Metals	15	19	3	1
2.	Strengthening Mechanisms	10	13	1	1
3.	Mechanical working of Metals	6	13	1	1
4.	Rolling	10	16	2	1
5.	Extrusion	8	13	1	1
6.	Forging	8	13	1	1
7.	Sheet metal forming processes	8	10	-	1
8.	Powder Metallurgy	10	13	1	1
	Total	75	110	10	8

OBJECTIVES

1.0 Plastic deformation of Metals

- 1.1 Know Miller & Miller Bravias Indices.
- 1.2 Find out the Miller & Miller Bravias indices for Different Planes and Directions.
- 1.3 Calculate the Planar Density for different planes.
- 1.4 Define Lattice Defect.
- 1.5 Classify Lattice defects.
- 1.6 Define (a) Point Defect, (b) Vacancy, (c) Substitutional impurity, (d) Interstitial impurity
- 1.7 Give the relation between number of vacancies and temperature
- 1.8 Define dislocation.
- 1.9 Define edge and screw dislocation.
- 1.10 Explain Edge Dislocation and Screw dislocation.
- 1.11 Know burgers vector and burgers circuit.
- 1.12 Define slip and slip system.
- 1.13 List the slip systems for F.C.C., B.C.C. & H.C.P. crystals.
- 1.14 Explain Slip with both Edge & Screw Dislocations.
- 1.15 Explain Dislocation climb & Cross slip.
- 1.16 Differentiate Edge & Screw Dislocations.
- 1.17 Define Critical Resolved Shear Stress (C.R.S.S).
- 1.18 Derive C.R.S.S for a single crystal.
- 1.19 Explain the low angle grain boundaries, stacking faults.
- 1.20 Explain Twinning.
- 1.21 Differentiate annealed & mechanical twins.
- 1.22 Identify twin planes of B.C.C., F.C.C and H.C.P.
- 1.23 Compare Slip with Twinning.
- 1.24 Define Jog & sessile dislocation.
- 1.25 Tell the Bauschinger effect.

2.0 Strengthening Mechanisms.

- 2.1 List different Strengthening mechanisms.
- 2.1 Explain strain hardening of a F.C.C. single crystal.
- 2.3 Explain Solid Solution Strengthening.
- 2.4 Explain Grain Boundary Strengthening.
- 2.5 Explain Precipitation Hardening.
- 2.6 Explain Dispersion Hardening.
- 2.7 Explain Yield point phenomenon & Strain Ageing.

3.0 Mechanical Working of Metals.

- 3.1 Define Mechanical working of Metals
- 3.2 Define hot working & Cold working.
- 3.3 Define cold shortness & hot shortness
- 3.4 List the causes and remedies of cold & hot shortness
- 3.5 List out the advantages and disadvantages of hot working and cold working.
- 3.6 Tell the Necessity of annealing to cold worked metal.
- 3.7 State various stages in annealing.
- 3.8 Explain recovery, re-crystallization and grain growth.
- 3.9 Define the re-crystallization temperature.
- 3.10 Explain the variables influencing the re-crystallization.

4.0 Rolling

- 4.1 Define Rolling.
- 4.2 Explain the rolling process.
- 4.3 Generalize the forces and geometrical relationships involved in rolling
- 4.4 Derive the Limiting Condition for Rolling (prove $\mu = \tan\alpha$).
- 4.5 Derive the Expression for Maximum Reduction in Rolling.
- 4.6 Summarize the main variables in rolling.
- 4.7 Classify the rolling mills with respect to number of rolls in each stand and the types of products to be manufactured.
- 4.8 List the different shapes and types of grooves.
- 4.9 Explain various types of rolling defects and their remedies.

5.0 Extrusion

- 5.1 Define Extrusion
- 5.2 Classify the extrusion processes.
- 5.3 Differentiate the direct and indirect extrusion processes.
- 5.4 List the extrusion equipment.
- 5.5 Discuss the variables in extrusion processes.
- 5.6 Explain the extrusion of tubes.
- 5.7 Tell the extrusion defects and their remedies.
- 5.8 Explain the production of seamless pipes.
- 5.9 Discuss about wire drawing process.

6.0 Forging

- 6.1 Define Forging.
- 6.2 Classify the forging operations.

- 6.3 Explain the open–die forging operations of Edging, Fullering, Swaging, Drawing down, Punching & Piercing.
- 6.4 Specify the importance of rotary swaging.
- 6.5 State the principles underlying the upset forging.
- 6.6 Explain the process of manufacture of bolt head.
- 6.7 Explain the cold heading process for manufacture of Nails.
- 6.8 Explain in detail the closed – die forging operation.
- 6.9 Tell the various forging defects and their remedies.

7. Sheet Metal Forming:

- 7.1 Explain Rubber forming operation and its importance.
- 7.2 Explain the spinning process.
- 7.3 Explain the Roll forming process.
- 7.4 Explain the shearing and blanking processes.
- 7.5 Explain the bending operations.
- 7.6 Explain stretch forming process.
- 7.7 Explain the uses of deep drawing process and its importance.
- 7.8 Discuss the deep drawing process.
- 7.9 Discuss the various deep drawn product defects – orange peel effect, stretcher strains, earing and their remedy.
- 7.10 Explain the re-drawing process

8. Powder Metallurgy.

- 8.1 State the importance of Powder Metallurgy.
- 8.2 List various steps involved in the production of Powder Metallurgy parts
- 8.3 Explain production of Metal Powders through
 - a. Atomization,
 - b. Carbonyl Process,
 - c. Thermal Reduction,
 - d. Electrolytic Deposition.
- 8.4 State the Characteristics of Metal powders.
- 8.5 Explain Die Compaction and Iso - Static Compaction.
- 8.6 Explain the Sintering Mechanism.
- 8.7 Explain Infiltration & Impregnation.
- 8.8 Discuss the Advantages and Limitations of Powder Metallurgy.
- 8.9 State the applications of Powder Metallurgy.

COURSE CONTENTS

1.0 Plastic deformation of Metals : Miller & Miller Bravis Indices for Planes and Directions, Planar Density, Lattice Defects, Slip and Slip system, Slip systems for F.C.C., B.C.C. & H.C.P. crystals, Dislocation Climb & Cross slip, Critical Resolved Shear Stress, Low angle grain boundaries, stacking faults, Twinning, Twin planes of B.C.C., F.C.C and H.C.P., Jog & sessile dislocation, Bauschinger effect.

2.0 Strengthening Mechanisms: Strain hardening of a F.C.C. single crystal, Solid Solution Strengthening, Grain Boundary Strengthening, Precipitation Hardening, Dispersion Hardening, Yield point phenomenon & Strain Ageing.

3.0 Mechanical working of Metals: Hot working & Cold working, Necessity of annealing to cold worked metal, Recovery, Re-crystallization and Grain Growth, Re-crystallization Temperature, Variables influencing the re-crystallization.

4.0 Rolling : Rolling Process, Forces and geometrical relationships involved in rolling, Limiting Condition for Rolling ($\mu = \tan \alpha$), Maximum Reduction in Rolling, Variables in rolling, Classification of rolling mills, different shapes and types of grooves, Rolling defects and their remedies.

5.0 Extrusion : Extrusion, Direct and Indirect extrusion process, extrusion equipment, variables in extrusion process, Extrusion of tubes, Extrusion defects and their remedies, Production of seamless pipes, Wire drawing process.

6.0 Forging: Forging, Open die forging operations Edging, Filleting, Swaging, Drawing down, Punching & Piercing, Rotary swaging. Principles of upset forging, Process of manufacture of bolt head, cold heading process for the manufacture of Nails, closed – die forging operations, forging defects and their remedies.

7.0 Sheet Metal Forming : Rubber forming, spinning, Roll forming process, shearing and blanking, bending operations, stretch forming, uses of deep drawing process and their importance, deep drawing process, deep drawn product defects – orange peel effect, stretcher strains, earing and their remedy, re-drawing process.

8.0 Powder Metallurgy : Various steps involved in Powder Metallurgy, Atomization, Carbonil Process, Thermal Reduction, Electrolytic Deposition, Characteristics of Metal powders, Die Compaction and Iso - Static Compaction, Sintering Mechanism, Infiltration & Impregnation, Advantages and Limitations of Powder Metallurgy, applications of Powder Metallurgy.

REFERENCE BOOKS

1. Mechanical metallurgy by G.E. Dieter.
2. Engineering metallurgy by Higgins.
3. Manufacture of Iron and Steel Vol.IV by Bash forth.
4. Introduction to Powder metallurgy by Sinha

NON – FERROUS EXTRACTIVE METALLURGY

Subject Title	:	Non – Ferrous Extractive metallurgy
Subject Code	:	Met – 705
Periods / Week	:	04
Periods per Semester	:	60

TIME SCHEDULE

S.No	Major Topics	Periods	Weightage of Marks	Short Type	Essay Type
1.	Copper Extraction	14	16	2	1
2.	Aluminium Extraction	12	16	2	1
3.	Zinc Extraction	7	13	1	1
4.	Lead Extraction	7	13	1	1
5.	Magnesium Extraction	5	13	1	1
6.	Titanium Extraction	5	13	1	1
7.	Zirconium Extraction	5	13	1	1
8.	Thorium Extraction	5	13	1	1
	Total	60	110	10	8

OBJECTIVES

After the completion of the course the students will be able to:

1.0 Copper extraction

- 1.1 List the properties
- 1.2 State the effect of impurities on properties.
- 1.3 Appreciate the uses.
- 1.4 Classify the ores.
- 1.5 State the native ores, oxide ores, and sulphide ores.
- 1.6 Give the chemical composition of the ore.
- 1.7 List the copper extraction plants in India.
- 1.8 State the extraction techniques of copper.
- 1.9 State the important steps in the pyrometallurgical extraction of copper.
- 1.8 Explain roasting process.
- 1.9 Explain the smelting of oxide & sulphide ores.
- 1.11 Explain the reverberatory smelting, flash smelting.
- 1.12 State the advantages of flash smelting over reverberatory smelting
- 1.12 Define the grade of matte.
- 1.13 Define converting.
- 1.14 State the purpose of converting.
- 1.15 Explain the two stages of converting with chemical reactions.
- 1.16 State the advantages of side blown converter.
- 1.17 Explain fire refining operation.
- 1.18 Explain electrolytic refining- multiple systems & series systems.
- 1.10 Explain hydrometallurgical extraction of copper with flow sheet
- 1.21 Explain the recovery of precious Metals with flow sheet
- 1.22 State the recent extraction techniques in copper extraction

2.0 Aluminum extraction

- 2.1 State the properties and applications of aluminum
- 2.2 State the different ores with chemical composition.
- 2.3 State the deposits of Aluminum in India.
- 2.4 List extraction plants of aluminum in India.
- 2.5 State the steps in the extraction of aluminum.
- 2.6 Explain purification of bauxite by Bayer process
- 2.7 Understand the factors effecting Bayer process
- 2.8 State the reasons for the unfeasibility of carbothermic reduction of alumina
- 2.9 State the role of Cryolite in the electrolytic reduction of alumina.
- 2.10 Explain the construction & operation of reduction cell.
- 2.11 Explain factors effecting Hall-Heroult process.
- 2.12 Define Anode effect.
- 2.13 State the causes & remedies of anode effect.
- 2.14 Know the necessity of refining Aluminium.

3.0 Zinc extraction

- 3.1 List the properties and uses of zinc.
- 3.3 Know the ores & their chemical composition.
- 3.4 List the deposits of zinc in India
- 3.5 List the extraction plants in India
- 3.6 List the extraction Methods & techniques.
- 3.7 Explain pyrometallurgical extraction.
- 3.8 Explain roasting.
- 3.9 State the purpose of roasting.
- 3.10 Define distillation.
- 3.11 Explain the horizontal retort process.
- 3.12 Explain the vertical retort process.
- 3.13 Distinguish between vertical retort and horizontal retort process.
- 3.13 Explain the electrothermic production of zinc.
- 3.14 Explain the blast furnace method of production of zinc (Imperial Smelting Process)
- 3.15 Explain the hydrometallurgical techniques for the production of zinc with flow sheet.
- 3.16 Understand galvanizing.

4.0 Lead extraction

- 4.1 List the properties & uses.
- 4.2 State the ores & their chemical composition.
- 4.3 List the deposits in India
- 4.4 List the extraction plants in India.
- 4.5 Explain the sinter – Roasting of lead ores with chemistry
- 4.6 Explain the smelting process in blast furnace.
- 4.7 Understand the chemistry.
- 4.8 Know the products.
- 4.9 Explain the treatment of base bullion.
- 4.10 Define drossing.
- 4.11 Define cupellation.

4.12 Explain the Parke's process of desilveration of lead.

5.0 Magnesium extraction

- 5.1 List the properties & uses
- 5.2 Name the ores & their chemical composition.
- 5.3 List the deposits in India.
- 5.4 List the extraction plants of Mg in India
- 5.5 Know the extraction techniques.
- 5.6 Explain the Dow's process of 'Mg' extraction.
- 5.7 Explain the Pidgeon process

6.0 Titanium extraction

- 6.1 State the properties and applications of titanium.
- 6.2 Name the ores & chemical composition.
- 6.3 Understand the metallothermic reduction of halides.
- 6.4 Know the treatment of ilmenite for up gradation.
- 6.5 Explain the chlorination of titanium oxide.
- 6.6 Explain the production of titanium by reduction of titanium tetrachloride (Kroll's process).
- 6.7 State the advantages of Mg-Na alloy reduction over Mg reduction
- 6.8 Explain melting of titanium sponge.
- 6.9 Explain the purification of titanium by Van Arkel's iodide process.
- 6.10 List the recent extraction techniques in the extraction of titanium

7.0 Zirconium extraction

- 7.1 State the properties of zirconium.
- 7.2 Know the applications of zirconium.
- 7.3 Name the ores of zirconium.
- 7.4 Understand the treatment of zircon.
- 7.5 Mention the Methods of separating the hafnium from zirconium.
- 7.6 Know the solvent extraction, fractional crystallization Methods.
- 7.7 Explain the production of pure zirconium oxide with flow sheet
- 7.8 Explain the production of zirconium sponge with flow sheet
- 7.9 Explain the production of mill products from sponge metal with a flow sheet
- 7.10 Know the production of zirconium powder.
- 7.11 Draw the flow diagram for the production of zirconium metal powder.

8.0 Thorium extraction.

- 8.1 State the properties.
- 8.2 State the applications of thorium.
- 8.3 List the ores & deposits of thorium in India.
- 8.4 Explain treatment of Monazite sands (alkali leaching).
- 8.5 Distinguish between Acid leaching and alkali leaching of Monazite
- 8.6 Understand the Methods of production of Thorium metal.
- 8.7 Draw the flow sheet for the production of reactor grade thorium nitrate.

COURSE CONTENTS:

- 1.0 Copper Extraction** Properties, uses, ores, Deposits, Extraction Plants in India, roasting, pyro metallurgical Extraction, reverberatory smelting, Flash smelting, converting, Fire refining, Electrolytic refining, Recovery of precious Metals, Hydrometallurgy of copper.
- 2.0 Aluminum Extraction** Properties, uses, ores, Deposits, Extraction plants in India, Bayer process, Hall Heroult's process, refining of Aluminum
- 3.0 Zinc Extraction:** Properties uses, ores, deposits, extraction plants in India, Extraction Methods, Roasting, distillation, Pyro metallurgical Extraction, Horizontal Retort, Vertical Retort process, Electro thermic reduction, Imperial smelting process, Hydro metallurgy; Galvanizing.
- 4.0 Lead Extraction:** Properties, uses, ores, deposits, Extraction plants, roasting, sintering, smelting in Blast Furnace, Treatment of base bullion, Refining of lead, Parke's process of desilverisation.
- 5.0 Magnesium Extraction** Properties, uses, ores, deposits, Pidgeon process, Dow process.
- 6.0 Titanium extraction** Properties, Applications, ores, deposits, metallothermic reduction, Treatment of Ilmenite, chlorination, kroll's process, Vanarkell's process.
- 7.0 Zirconium Extraction; Properties,** Uses, ores, Treatment of Zircon, Solvent extraction, Fractional crystallization, production of pure zirconium oxide, Zirconium sponge, Zircalloy -2 Tubes, Zirconium Metal powder.
- 8.0 Thorium Extraction;** Properties, Uses, Ores, Treatment of Monazite sands, Alkali Leaching, Methods of Thorium Metal production, production of reactor grade thorium nitrate

REFERENCE BOOKS

1. Non-ferrous Extractive metallurgy – by Ray, Abraham & Sridhar
2. Non-ferrous extractive metallurgy – by Dennis
3. Elements of metallurgy – by Dr. Swaroop

Non-Destructive Testing Lab

Subject title : **Non-Destructive Testing Lab**
Subject Code : **Met -706**
Periods per week : **03**
Periods per semester : **45**

S.No.	Experiment	No. Of Periods
1.	Liquid Penetrant Test	06
2.	Magnetic Particle Test Longitudinal Crack Detection	06
3.	Magnetic Particle Test Transverse Crack Detection	06
4.	Ultrasonic Test Calibration of Equipment with V- block	09
5.	Ultrasonic Test Detection of Flaws using standard Blocks	12
6.	Eddy Current Test	06
	Total periods	45

OBJECTIVES

On the completion of course a student should be able to:

1. Know how to conduct the liquid penetrant test to locate the surface cracks on the given material.
2. Detect longitudinal surface and sub surface defects in the given materials by magnetic particle test.
3. Detect transverse surface and sub surface defects in the given materials by magnetic particle test.
4. Calibrate the ultrasonic flaw detector using V-blocks and measure the thickness of given sample.
5. Detect the flaws in metallic objects using ultrasonic flaw detector.
6. Detect the defects in given objects by using Eddy current test.

Course Content

1. Determination of surface cracks by liquid penetrant test.
2. Identification of surface and sub-surface cracks by magnetic particle test
 - i) longitudinal methods
 - ii) Transverse method.
3. Calibration of ultrasonic flaw detector using IIW test blocks and measure the thickness of given sample.
4. Identification of flaws by ultrasonic flaw detector.
5. Determination of the defects by using Eddy current test.

Key competencies

Exercise	Key competencies expected
Liquid Penetrant test	Prepare the sample for the test <ul style="list-style-type: none"> • Identify the chemicals used • Distinguish the chemicals employed • Identify the cracks and interpret the result. • Know the industrial applications.
Magnetic Particle Test (Longitudinal Crack Detection)	<ul style="list-style-type: none"> • Prepare the equipment with relevant connections. • Prepare the sample for the test • Identify the material suitability for the test • Self Handling of the Equipment • Identify the magnetic media for the test • Set the equipment for longitudinal magnetization • Identifying the cracks • Know the industrial applications
Magnetic Particle Test (Transverse Crack Detection)	<ul style="list-style-type: none"> • Prepare the sample for the test • Identify the material suitability for the test • Self Handling of the Equipment • Set the equipment for transverse magnetization. • Identifying the cracks • Know the industrial applications
Ultrasonic Test (Calibration of equipment)	<ul style="list-style-type: none"> • Recognise the IIW test block • Prepare the equipment with relevant connections • Identify the probes for the test • Knowing the connections for the equipment • Fixing the different settings for calibration of the equipment. • Measure the thickness of the object. • Know the industrial applications
Ultrasonic Test (Flaws detection)	<ul style="list-style-type: none"> • Prepare the standard test blocks with flat bottom holes • Identify the flaws and interpret the results. • Know the industrial applications
Eddy current Test.	<ul style="list-style-type: none"> • Identify the material suitability for the test • Prepare the equipment with relevant connections. • Know the industrial applications

LIFE SKILLS

(Common with all Branches)

Subject Title : **Life skills**
Subject Code : **MET – 707**
Periods per week : **03**
Period per semester : **45**

TIME SCHEDULE

Sl No.	UNITS	No. of periods Allotted		
		Explanat ion	Activities	Total
1.	ATTITUDE	1	3	4
2.	ADAPTABILITY	1	3	4
3.	GOAL SETTING	1	3	4
4.	MOTIVATION	1	3	4
5.	TIME MANAGEMENT	1	3	4
6.	CRITICAL THINKING	2	3	5
7.	CREATIVITY	1	3	4
8.	PROBLEM SOLVING	1	3	4
9.	TEAM WORK	1	3	4
10.	LEADERSHIP	1	3	4
11.	STRESS MANAGEMENT	1	3	4
TOTAL		12	33	45

Note: No Written Examination; The total 45 hours are to be considered as Theory hours.

Marks: Internal – 40; External – 60

OBJECTIVES:

Upon the completion of this course, the student shall be able to

1.0 Understand the concept of Attitude

- 1.1 Define 'Attitude'
- 1.2 Explain the importance of Attitude
- 1.3 Distinguish between Positive and Negative Attitudes
- 1.4 Life Response: Need for change of Attitude
- 1.5 Positive Attitude: Key to success in Personal and Professional Lives

2.0 Understand the concept of Adaptability

- 2.1 Define the term 'Adaptability'
- 2.2 Explain the concept of Adaptability
- 2.3 Advantages of Adaptability
- 2.4 Disadvantages of Lack of Adaptability
- 2.5 Need for positive response to change

3.0 Understand the concept of Goal setting

- 3.1 Define the terms 'Goal' and 'Goal Setting'
- 3.2 Explain the significance of Goal setting & Long and Short term goals
- 3.3 Explain the following concepts
 - a) Wish
 - b) Dream
 - c) Goal
- 3.4 Explain the reasons for and consequences of not setting goals
- 3.5 The SMART features in Goal setting

4.0 Understand the concept of Motivation

- 4.1 Define 'Motivation' ; Inspiration Vs Motivation
- 4.2 Importance of motivation in Goal setting
- 4.3 Distinguish between Internal (Self) Motivation and External Motivation
- 4.4 De-motivating Factors and how to overcome them
- 4.5 Motivating oneself and others

5.0 Understand Time Management skills

- 5.1 Define 'Time Management'.
- 5.2 Comprehend the significance of Time Management.
- 5.3 Explain the Time Quadrant
- 5.4 Common Time wasters and how to overcome them.
- 5.5 How to meet deadlines and targets within time

6.0 Understand Critical Thinking

- 6.1 Define "Critical Thinking",
- 6.2 Understand the importance of Critical Thinking
- 6.3 Distinguish between facts and opinions (assumptions)
- 6.4 Inculcating different perspectives
- 6.5 Developing Reasoning abilities and form sound judgments

7.0 Understand Creativity

- 7.1 Understand the importance of and need for creative ideas
- 7.2 Distinguish between Linear Thinking and Lateral Thinking
- 7.3 Distinctive qualities of creative people
- 7.4 Unusual or creative use of familiar objects
- 7.5 Creative ways of solving problems

8.0 Understand Problem Solving

- 8.1. Define the concept of Problem solving
- 8.2 Viewing the problems as challenges

- 8.3 Different steps in solving a problem
- 8.4 Selecting the best solution to solve a problem
- 8.5 Lateral thinking in Problem solving

9.0 Understand Team Work

- 9.1 Define Team work
- 9.2 Develop Team skills
- 9.3 Advantages of team work
- 9.4 Understand responsibilities as a team player
- 9.5 Problems of working in a team and possible solutions

10.0 Understand Leadership

- 10.1 Define Leadership
- 10.2 Identify Leadership qualities
- 10.3 Analyze one's strengths and limitations as a leader
- 10.4 Types of Leadership: Autocratic and Democratic
- 10.5 Leadership by example

11.0 Understand Stress Management

- 11.1 Define Stress
- 11.2 Explain the causes of stress
- 11.3 Learn Stress Management skills
- 11.4 Need for positive thinking and self esteem
- 11.5 Practice Stress Management strategies

METAL CASTING PRACTICE & CAD LAB

Subject Title	:	Metal casting practice & CAD Lab
Subject Code	:	Met – 708
Total No. of Periods	:	06
Total Periods Per Semester	:	90

TIME SCHEDULE

Sl.No.	Experiment Title	No. of periods
1	Operation of pit furnace for melting of Aluminium and its alloys	15
2	Operation of induction furnace for melting of cast iron	18
3	Analysis of casting defects	15
4	Introduction to CAD, toolbars & menus	21
5	Dimensioning & Hatching and 2D drawings	21
Total periods		90

OBJECTIVES

Up on Completion of the course the student shall be able to:

- 1.0 Operation of pit furnace for melting of Aluminium alloys**
 - 1.1 Parts of the pit furnace
 - 1.2 Know the melting point of aluminium and its alloys
 - 1.3 Know the raw material composition
 - 1.4 Know the charging sequence
 - 1.5 Maintaining of furnace temperature
 - 1.6 Melting of charge material
 - 1.7 Reduce of dross formation
 - 1.8 Types of fluxes used in melting aluminium alloys

- 2.0 Operation of induction furnace for melting of cast iron**
 - 2.1 Parts of the induction furnace
 - 2.2 Know the melting point of cast iron
 - 2.3 Know the raw material composition
 - 2.4 Know the charging sequence
 - 2.5 Maintaining of furnace temperature
 - 2.6 Melting of charge material
 - 2.7 Tapping of molten metal.

- 3.0 Analysis of casting defects**
 - 3.1 Removal of casting from the mould
 - 3.2 Removal of gates and risers
 - 3.3 Removal of sand and other metal projections from casting surface
 - 3.4 Observe the casting defects like blow holes, pin holes etc.
 - 3.5 Analyse the reasons for casting defects

4.0 Introduction to CAD, toolbars & menus

- 4.1 Define Computer Aided Drafting
- 4.2 List the Advantages of CAD
- 4.3 Explain the importance of CAD software
- 4.4 Explain the features of Graphic Work station
- 4.5 Use CAD Environment: Screen, Various tool bars and menus.
- 4.6 Practice commands using toolbars, menus, command bar
- 4.7 Practice repeating a command, Nesting a command and modifying a command
- 4.8 Use prompt history window and scripts
- 4.9 Practice mouse shortcuts, Practice the Creating the drawing, Opening existing and damaged Files, saving the drawing

5.0 Dimensioning & Hatching and 2D drawings

- 5.1 Explain about Dimensioning and Hatching
- 5.2 Draw the 2D – drawings of simple patterns.
- 5.3 Explain about 3D solids and solids tool bar options

COURSE CONTENT

1. Operation of pit furnace for melting of Aluminium and its alloys
2. Operation of induction furnace for melting of cast iron
3. Analyse the casting defects and cleaning of castings
4. Introduction to CAD and understand of auto CAD graphic user Interface (GUI).
5. Use proper 2D commands to create 2D drawings

PROJECT WORK & VIVA VOCE

Subject title	:	Project work & Viva Voce
Subject Code	:	Met – 709
Periods /Week	:	06
Period /semester	:	90

A list of Topics suggested for project work.

1. Design and fabrication of small proto type metallurgical Engineering equipment such as furnace etc. useful for demonstration in the laboratory.
2. Study of the effect of various heat treatment processes on the microstructures & properties of ferrous, non-ferrous metals & alloys.
3. Collection of different ferrous and non-ferrous metal samples and compiles the metallographic data with photographs.
4. Identify castings and interpretation of defects on various metallic components by using NDT Techniques.
5. Preparation of Castings for different ferrous & Non-ferrous Alloys.
6. Any other project in consultation with industry / R & D Laboratory.