B.Tech - Regulations, Course Structure and syllabus

For

DEPARTMENT OF METALLURGICAL ENGINEERING

UNIVERSITY COLLEGE OF ENGINEERING VIZIANAGARAM

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

(Applicable for batches admitted from 2019-2020)

JNTUK-University College of Engineering Vizianagaram

ACADEMIC REGULATIONS (R19)

For

B.Tech. Four Year Degree Programme

(Applicable for the batches admitted from the **A.Y. 2019-20**)

UNIVERSITY COLLEGE OF ENGINEERING VIZIANAGARAM

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

VIZIANAGARAM – 535003, ANDHRA PRADESH, INDIA.

ACADEMIC REGULATIONS (R19) FOR B. TECH. (REGULAR)

Applicable for the students of B. Tech. (Regular) from the Academic Year 2019-20 onwards

1. **Award of B. Tech. Degree**

A student will be declared eligible for the award of B. Tech. Degree if he fulfils the following academic regulations:

1. A student shall be declared eligible for the award of the B. Tech Degree, if he pursues a course of study in not less than four and not more than eight academic years.
2. The candidate shall register for 160 credits and secure all the 160 credits.

2. **Courses of study**

The following courses of study are offered at present as specializations for the B. Tech. Courses:

S. No	Branch
01	Civil Engineering
02	Electrical and Electronics Engineering
03	Mechanical Engineering
04	Electronics and Communication Engineering
05	Computer Science and Engineering
06	Information Technology
07	Metallurgical Engineering

3. **Distribution and Weightage of Marks**

(i) The performance of a student in each semester shall be evaluated subject – wise with a maximum of **100 marks for theory subject** and **75 marks for practical subject**. The project work shall be evaluated for 200 marks.

(ii) For theory subjects the distribution shall be 30 marks for Internal Evaluation and 70 marks for the End - Examinations.

(iii) For theory subjects, during a semester, there shall be two mid-term examinations. Each mid-term examination consists of one objective paper, one descriptive paper and one assignment. Total duration of mid-term exam is 1 hour 50 minutes (20 minutes for objective and 90 minutes for descriptive paper). The objective paper shall contain 20 multiple choice questions, for a total of 10 marks. The descriptive paper shall contain 3 questions for 15 marks; the student has to answer all questions. While the first mid-term examination shall be conducted on 50% of the syllabus, the second mid-term examination shall be conducted on

the remaining 50% of the syllabus. Five marks are allocated for assignments (as specified by the subject teacher concerned). The first assignment should be submitted before the conduct of the first mid-term examination, and the second assignment should be submitted before the conduct of the second mid-term examination. The total marks secured by the student in each mid-term examination are evaluated for 30 marks.

(iv) Internal Marks can be calculated with 80% weightage for better of the two Mids and 20% weightage for other Mid Exam. As the syllabus is framed for 5 units, the 1st mid examination (Objective, Subjective and assignment) is conducted in 1, 2 & Half of -3 units and second test in remaining half of 3 unit,4&5 units of each subject in a semester.

Final internal Marks = (Best Mid marks x 0.8 + other Mid marks x 0.2)

(v) The semester end examinations will be conducted for 70 marks consists of FIVE questions carrying 14 marks each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

(vi) For practical subjects there shall be continuous evaluation during the semester for 25 internal marks and 50 end examination marks. The internal 25 marks shall be awarded as follows: day to day work and record-15 marks and the remaining 10 marks to be awarded by conducting an internal laboratory test. The end examination shall be conducted by the teacher concerned and external examiner as follows:

	Procedure	*Experimentation*	*Result*	*Viva-voce*	*Total*
Marks	15	15	10	10	50

(vii) For the subject having design and / or drawing, (such as Engineering Graphics, Engineering Drawing, Machine Drawing) and estimation, the distribution shall be 30 marks for internal evaluation (20 marks for day-to-day work, and 10 marks for internal tests) and 70 marks for end examination. There shall be two internal tests in a Semester and the Marks for 10 can be calculated with 80% weightage for best of the two tests and 20% weightage for other test and these are to be added to the marks obtained in day to day work.

(viii) For the seminar, each student has to be evaluated based on the presentation of any latest topic with report of 10-15 pages and a presentation (viz., ppt or any of min 10 slides). The student shall collect the information on a specialized topic and prepare a technical report, showing his understanding over the topic, and submit to the department, which shall be evaluated by the Departmental committee consisting of Head of the department, seminar supervisor and a senior faculty member. *The seminar report shall be evaluated for 50 marks. There shall be no external examination for seminar.*

(ix) Audit Course/Non-Credit Course (AC/NC): There shall be AC/NC courses with zero credits. There shall be no external examination. However, attendance in the audit course shall be considered while calculating aggregate attendance and student shall be declared to have passed the mandatory course only when he/she secures 40% or more in the internal/mid examinations. In case, the student fails, a re-examination shall be conducted for failed candidates every six months/semester at a mutually convenient date of college/student satisfying the conditions mentioned in item 1 & 2 of the regulations.

(x) Mandatory Course (MC): There shall be MC with zero credits. There shall be no external examination. However, attendance in the mandatory course of minimum attendance (75%) in that particular subject.

(xi) **Engineering Exploration Project**: Engineering Exploration Project is offered to the First year students of all engineering disciplines. The motivation of including this in the curriculum is to make the students practice creative problem solving method - Design Thinking which fosters collaboration and solve problems in human-centered ways. It enables the students to exercise and identify design opportunities through various phases with the help of hands-on activities. Obtaining a best solution for an identified problem involves a non-linear, iterative process which seeks to understand users, challenge assumptions, redefine problems and create innovative solutions to prototype and test. The students are encouraged to explore real-world problems and expected to take charge of their own learning, work together in teams towards the problem.
The evaluation of the Engineering Exploration Project involves in writing their observations in Activity Cards at the end of each task given in syllabus and submitting a final report along with working prototype.
It shall be evaluated for 50 marks as an external. The committee consists of an external examiner, Head of the Department and a supervisor/ mentor. There shall be no internal marks.

(xii) **Socially Relevant Project**: The students are encouraged to explore socially relevant problems in and around, and expected take charge of their own learning, work together in teams towards the problem. The evaluation of socially relevant project involves submitting a survey report about the problem along with suitable working prototype for the solution. It shall be evaluated for 50 marks as an external. The committee consists of an external examiner, Head of the Department and a supervisor/ mentor. There shall be no internal marks.

(xiii) **Procedure for Conduct and Evaluation of MOOC**: There shall be a Discipline Centric Elective Course through Massive Open Online Course (MOOC) as Program Elective course. The student shall register for the course (Minimum of 12 weeks) offered by SWAYAM/NPTEL/JNTUK MOOCS through online with the approval of Head of the Department.
The Head of the Department shall appoint one mentor for each of the MOOC subjects offered. The student needs to register the course in the SWAYAM/NPTEL portal in the previous semester. During the course, the mentor monitors the student's assignment submission given by SWAYAM/NPTEL at the end of every week. The student needs to submit all the assignments given and needs to take final exam at the proctor center. The student needs to earn a certificate by passing the exam. The student will be awarded the credits given in curriculum only by submission of the certificate.
For JNTUK MOOCS course, the mentor appointed shall conduct the mid semester examinations as per 3(iii). Further, the University shall conduct the external examination for the MOOC subject in line with other regular subjects based on the syllabi of the respective subject provided in the curriculum. A MOOC course may be studied either in online or in conventional manner.
In case if the student does not pass in SWAYAM/NPTEL, the alternative subject maybe taken from JNTUK MOOCS and has to pass the course as per 3(iii)
Open Electives are evaluated as per 3(iii)

(xiv) Induction program is mandatory for all first year UG students and shall be conducted as per Semester -0 course structure.

(xv) Mini Project/Internship guidelines: There shall be an Industrial Oriented Mini Project/Summer Internship, in collaboration with an industry of their specialization. Students will register for this immediately after III year II semester examinations and pursue it during summer vacation. Industrial Oriented Mini Project/Summer Internship shall be submitted in a technical report form and presented before the committee in IV year I semester. It shall be evaluated for 50 external marks. The committee consists of an external examiner, Head of the Department, supervisor of the Industrial Oriented mini project/Summer Internship and a senior faculty member of the department. There shall be no internal marks for Industrial Oriented Mini Project/Summer Internship.

(xvi) UG project work shall be carried out in two stages: Project Stage – I during IV Year I Semester, Project Stage – II during IV Year II Semester. Each stage will be evaluated for 100 marks. Student has to submit project work report at the end of each semester. First report includes project work carried out in IV Year I semester and second report includes project work carried out in IV Year I & II Semesters. External evaluation for both project stages shall be completed before the commencement of end Theory examinations.

(xvii) Out of a total of 200 marks for the project work, 60 marks shall be for Internal Evaluation and 140 marks for the End Semester Examination. The End Semester Examination (Viva-Voce) shall be conducted by the committee. *The committee consists of an external examiner, Head of the Department and Supervisor of the Project*. The evaluation of project work shall be conducted at the end of the IV year. *The Internal Evaluation shall be on the basis of two seminars given by each student on the topic of his project and evaluated by an internal committee*.

4. Attendance Requirements

1. A student is eligible to write the External examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.
2. Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee.
3. Shortage of Attendance below 65% in aggregate shall not be condoned.
4. A student who is short of attendance in semester may seek re-admission into that semester when offered within 4 weeks from the date of the commencement of class work.
5. Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class.
6. A stipulated fee shall be payable towards condonation of shortage of attendance.
7. A student will be promoted to the next semester if he satisfies the (i) attendance requirement of the present semester and (ii) minimum required credits.
8. If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

5. Minimum Academic Requirements

The following academic requirements have to be satisfied in addition to the attendance requirements mentioned in item no.4:

5.1 A student is deemed to have satisfied the minimum academic requirements if he has **earned the credits allotted to each theory/practical design/drawing subject/project and secures not less than 35% of marks in the end semester exam, and minimum 40% of marks in the sum total of the internal marks and end semester examination marks.**

5.2 A student shall be promoted from first year to second year if he fulfills the minimum attendance requirement.

5.3 A student will be **promoted from II year to III year** if he fulfills the academic requirement **of 40% of the credits up to either II year I semester from all the examinations.**

5.4 A student shall be **promoted from III year to IV year** if he fulfils the academic requirements of **40% of the credits up to either III year I semester from all the examinations.**

5.5 A student shall register and put up minimum attendance in all 160 credits and earn all 160 credits.

6. Course Pattern

1. The entire course of study is for four academic years; all the years are on semester pattern.
2. A student eligible to appear for the end semester examination in a subject, but absent from it or has failed in the end semester examination, may write the exam in that subject when conducted next.
3. When a student is detained for lack of credits / shortage of attendance, he may be re-admitted into the same semester / year in which he has been detained. However, the academic regulations under which he was first admitted shall continue to be applicable to him.

6. GRADING SYSTEM

Marks Range Theory (Max – 100)	Marks Range Lab (Max – 50)	Letter Grade	Level (G)	Grade Point
≥ 90	≥ 45	>90	Outstanding (O)	10
≥80 to <90	≥40 to <45	90-80	Excellent (S)	9
≥70 to <80	≥35 to <40	80-70	Very Good (A)	8
≥60 to <70	≥30 to <35	70-60	Good (B)	7
≥50 to <60	≥25 to <30	60-50	Fair (C)	6
≥40 to <50	≥20 to <25	50-40	Satisfactory (D)	5
<40	<20	<40	Fail (F)	0
--	--	--	Absent	0

The following procedure is to be adopted to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

Computation of SGPA

The **SGPA** is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

$$\mathbf{SGPA\ (S_i) = \sum (C_i\ X\ G_i) / \sum C_i}$$

Where C_i is the number of credits of the ith course and G_i is the grade point scored by the student in the i^{th} course.

Computation of CGPA

The **CGPA** is also calculated in the same manner taking into account all the courses undergone by a student over all the semester of a programme, i.e.

$$\mathbf{CGPA = \sum (C_i\ X\ S_i) / \sum C_i}$$

Where S_i is the SGPA of the i^{th} semester and Ci is the total number of credits in that semester. The SGPA and CGPA shall be rounded off to TWO decimal points and reported in the transcripts.

7. Award of Class

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he/she shall be placed in one of the following four classes:

Class Awarded	**CGPA to be secured**	
First Class with Distinction	≥ 7.75 without supple history	**From the CGPA secured from 160 Credits.**
First Class	≥ 6.75 with supple history	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 4.75 to < 5.75	

8. Minimum Instruction Days: The minimum instruction days for each semester shall be 90 working days.

10. There shall be no branch transfers after the completion of the admission process.
11. There shall be no transfer from one college/stream to another within the Constituent Colleges and Units of Jawaharlal Nehru Technological University Kakinada.

12. **WITHHOLDING OF RESULTS**

If the student has not paid the dues, if any, to the university or if any case of indiscipline is pending against him, the result of the student will be withheld. His degree will be withheld in such cases.

13. **TRANSITORY REGULATIONS**

1. Discontinued or detained candidates are eligible for readmission as and when next offered.
2. The readmitted students will be governed by the regulations under which the candidate has been admitted.

14. **General**

1. Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.
2. The academic regulation should be read as a whole for the purpose of any interpretation.
3. In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.
4. The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

ACADEMIC REGULATIONS (R19) FOR B. TECH. (LATERAL ENTRY SCHEME)

Applicable for the students admitted into II year B. Tech. from the Academic Year **2020-21** onwards

1. **Award of B. Tech. Degree**
   A student will be declared eligible for the award of B. Tech. Degree if he fulfils the following academic regulations:
   1.1 A student shall be declared eligible for the award of the B. Tech Degree, if he pursues a course of study in not less than three academic years and not more than six academic years.
   1.2 The candidate shall register for **120 CREDITS** credits and secure all the credits.

2. The attendance regulations of B. Tech. (Regular) shall be applicable to B.Tech. (Lateral Entry Scheme).

3. **Promotion Rule**

   A student shall be promoted from second year to third year if he fulfills the minimum attendance requirement.
   A student shall be promoted from III year to IV year if he fulfils the academic requirements of 50% of the credits up to III year I semester from all the examinations.

4. **Award of Class**

   After a student has satisfied the requirement prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he shall be placed in one of the following four classes:

Class Awarded	**CGPA to be secured**	**From the CGPA secured from 120 Credits from II Year to IV Year**
First Class with Distinction	≥ 7.75 with no failures	
First Class	≥ 6.75 to <7.75	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 4.75 to < 5.75	

   The marks obtained in the internal evaluation and the end semester examination shall be shown separately in the marks memorandum.

5. All the other regulations as applicable to **B. Tech. 4-year degree course (Regular) will hold good for B. Tech. (Lateral Entry Scheme)**.

MALPRACTICES RULES

DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	**Punishment**
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all External examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all External examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.

6.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all External examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

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JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA-533003, Andhra Pradesh (India)
For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

Prohibition of ragging in educational institutions Act 26 of 1997

Salient Features

- Ragging within or outside any educational institution is prohibited.
- Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student

	Imprisonment upto		Fine Upto
Teasing, Embarrassing	6 Months	+	Rs. 1,000/-
Assaulting or Using Criminal force or Criminal intimidation	1 Year	+	Rs. 2,000/-
Wrongfully restraining or confining or causing hurt	2 Years	+	Rs. 5,000/-
Causing grievous hurt, kidnapping or Abducts or rape or committing unnatural offence	5 Years	+	Rs. 10,000/-
Causing death or abetting suicide	10 Months	+	Rs. 50,000/-

LET US MAKE JNTUK A RAGGING FREE UNIVERSITY

In Case of Emergency CALL TOLL FREE NO. : 1800 - 425 - 1288

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA
KAKINADA-533003, Andhra Pradesh (India)

For Constituent Colleges and Affiliated Colleges of JNTUK

Ragging

ABSOLUTELY NO TO RAGGING

1. Ragging is prohibited as per Act 26 of A.P. Legislative Assembly, 1997.
2. Ragging entails heavy fines and/or imprisonment.
3. Ragging invokes suspension and dismissal from the College.
4. Outsiders are prohibited from entering the College and Hostel without permission.
5. Girl students must be in their hostel rooms by 7.00 p.m.
6. All the students must carry their Identity Cards and show them when demanded
7. The Principal and the Wardens may visit the Hostels and inspect the rooms any time.

Jawaharlal Nehru Technological University Kakinada
For Constituent Colleges and Affiliated Colleges of JNTUK

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Course Structure

I Year **I Semester**

S. No	Course Code	Course Title	L	T	P	Credits
1	HS	Communicative English	3			3
2	BS	Calculus	3			3
3	BS	Engineering Chemistry	3			3
4	ES	Problem Solving and Programming using C	3			3
5	ES	Engineering Graphics and Drafting	1		3	2.5
6	HS	English communication skills lab-I			3	1.5
7	BS	Engineering Chemistry lab			3	1.5
8	ES	Mechanical workshop practice			3	1.5
9	ES	Problem Solving and Programming using C - lab			3	1.5
10	MC	Constitution of India	3			0
11	MC	Physical Fitness Activities/ Yoga				
		Total Credits				20.5

I Year **II Semester**

S. No	Course Code	Course Title	L	T	P	Credits
1	BS	Linear Algebra and Numerical Methods	3			3
2	BS	Engineering Physics	3			3
3	ES	Engineering Mechanics	3			3
4	ES	Basic Electrical and Electronics Engineering	3			3
5	ES	Computer-Aided Engineering Drawing	1		3	2.5
6	HS	English Communication Skills lab-II			3	1.5
7	BS	Engineering Physics lab			3	1.5
8	BS	Physics Virtual lab			2	0
9	ES	Basic Electrical & Electronics Engineering Lab			3	1.5
10	PR	Engineering Exploration Project – Design Thinking (15 hrs per semester)				0.5
11	MC	Professional Ethics and Human Values	3			0
		Total Credits				19.5

II Year **I Semester**

S. No	Course Code	Course Title	L	T	P	Credits
1	PCC	Mineral Processing	3	0	0	3
2	PCC	Physical Metallurgy	3	0	0	3
3	BS	Vector calculus, Transformations and Partial Differential Equations	3	0	0	3
4	PCC	Thermodynamics and Kinetics	3	1	0	4
5	PCC	Metallurgical Analysis	3	0	0	3
6	PCC	Mineral Processing lab	0	0	3	1.5
7	LC	Physical Metallurgy Lab	0	0	3	1.5
8	LC	Metallurgical Analysis Lab	0	0	3	1.5
		Total Credits				**20.5**

II Year **II Semester**

S. No	Course Code	Course Title	L	T	P	Credits
1	PCC	Iron Making	3	0	0	3
2	ES	Elements of Mechanical Engineering	3	0	0	3
3	BS	Complex Variables and statistical Methods	3	0	0	3
4	PCC	Phase Transformation and Heat Treatment	3	0	0	3
5	PE	Professional Elective-I: 1. Fuels, Furnaces and Refractories 2. Light Metal Technology 3. Computational Materials Engineering	3	0	0	3
6	PCC	Foundry Technology	3	0	0	3
7	LC	Phase Transformation and Heat Treatment Lab	0	0	3	1.5
8	LC	Foundry Technology Lab	0	0	3	1.5
		Total Credits				**21**

III Year **I Semester**

S. No	Course Code	Course Title	L	T	P	Credits
1	PCC	Mechanical Behaviour of Materials	3	0	0	3
2	PCC	Steel Making	3	0	0	3
3	PCC	Corrosion Engineering	3	0	0	3
4	PCC	Non-ferrous Extractive Metallurgy	3	0	0	3
5	PE	Professional Elective-II: 1. Magnetic and Electronic Materials 2. Nuclear Materials 3. Advanced Manufacturing Technology	3	0	0	3
6	OE	Open Elective-I: 1. Introduction to Materials Engineering 2. Basics of Crystallography 3. Metallurgical Process Modelling	3	0	0	3
7	LC	Corrosion Lab	0	0	3	1.5
8	LC	Mechanical Testing Lab	0	0	3	1.5
		Total Credits				**21**

III Year **II Semester**

S. No	Course Code	Course Title	L	T	P	Credits
1	PCC	Materials Characterization	3	0	0	3
2	PCC	Non-destructive Testing	3	0	0	3
3	PCC	Powder Metallurgy	3	0	0	3
4	PE	Professional Elective-III: 1. Surface Engineering and Tribology 2. Transport Phenomenon 3. Alternative routes of iron and steel making	3	0	0	3
5	OE	Open Elective-II: 1. Materials Testing 2. Chemical Analysis of Metals 3. Materials for Extreme Environment	3	0	0	3
6	PCC	Ferro Alloy Technology	3	0	0	3
7	LC	Materials Characterization Lab	0	0	3	1.5
8	LC	Non-destructive Testing Lab	0	0	3	1.5
		Total Credits				**21**

IV Year **I Semester**

S. No	Course Code	Course Title	L	T	P	Credits
1	PCC	Materials Joining Technology	3	0	0	3
2	PCC	Composite Materials	3	0	0	3
3	PE	Professional Elective-IV: 1. Solidification Processing 2. Metallurgical Failure Analysis 3. Polymer Science and Technology	3	0	0	3
4	OE	Open Elective-III: 1. Functional Materials 2. High Temperature Materials 3. Biomaterials	3	0	0	3
5	PR	Project Work (Phase-I)	0	0	0	2.5
6	PR	Internship Followed by Seminar	0	0	0	1
7	LC	Materials Joining Lab	0	0	3	1.5
8	LC	Composite Materials Lab	0	0	3	1.5
		Total Credits				**18.5**

IV Year **II Semester**

S. No	Course Code	Course Title	L	T	P	Credits
1	HSSMS	Introduction to Industrial Management	3	0	0	3
2	PCC	Nanomaterials	3	0	0	3
3	PE	Professional Elective-V: 1. Fatigue and Fracture Mechanics 2. Energy Materials 3. Ceramic Science and Technology	3	0	0	3
4	LC	Nano Materials Lab	0	0	2	1
4	PR	Project Work (Phase-II)	0	0	0	8
		Total Credits				**18**

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L	T	P	C
3	0	0	3

B.Tech I Year I Semester
Communicative English
(Common to all Branches)

Introduction

The course is designed to train students in receptive (listening and reading) as well as productive and interactive (speaking and writing) skills by incorporating a comprehensive, coherent and integrated approach that improves the learners' ability to effectively use English language in academic/ workplace contexts. The shift is from *learning about the language* to *using the language*. On successful completion of the compulsory English language course/s in B.Tech., learners would be confident of appearing for international language qualification/proficiency tests such as IELTS, TOEFL, or BEC, besides being able to express themselves clearly in speech and competently handle the writing tasks and verbal ability component of campus placement tests. Activity based teaching-learning methods would be adopted to ensure that learners would engage in actual use of language both in the classroom and laboratory sessions.

Course Objectives:

- Facilitate effective listening skills for better comprehension of academic lectures and English spoken by native speakers
- Focus on appropriate reading strategies for comprehension of various academic texts and authentic materials
- Help improve speaking skills through participation in activities such as role plays, discussions and structured talks/oral presentations
- Impart effective strategies for good writing and demonstrate the same in summarizing, writing well organized essays, record and report useful information
- Provide knowledge of grammatical structures and vocabulary and encourage their appropriate use in speech and writing

Unit I:

Lesson-1: A Drawer full of happiness from "**Infotech English**", Maruthi Publications

Lesson-2: Deliverance by Premchand from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Listening to short audio texts and identifying the topic. Listening to short audio texts and identifying the context and specific pieces of information to answer a series of questions both in speaking and writing.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests. Self introductions and introducing others.

Reading: Skimming text to get the main idea. Scanning to look for specific pieces of information.

Reading for Writing: Paragraph writing (specific topics) using suitable cohesive devices; linkers, sign posts and transition signals; mechanics of writing - punctuation, capital letters.

Vocabulary: Technical vocabulary from across technical branches (20) GRE Vocabulary (20) (Antonyms and Synonyms, Word applications) Verbal reasoning and sequencing of words.

Grammar: Content words and function words; word forms: verbs, nouns, adjectives and adverbs; nouns: countables and uncountables; singular and plural basic sentence structures; simple question form - wh-questions; word order in sentences.

Pronunciation: Vowels, Consonants, Plural markers and their realizations

Unit II:

Lesson-1: Nehru's letter to his daughter Indira on her birthday from "**Infotech English**", Maruthi Publications

Lesson-2: Bosom Friend by Hira Bansode from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Answering a series of questions about main idea and supporting ideas after listening to audio texts, both in speaking and writing.

Speaking: Discussion in pairs/ small groups on specific topics followed by short structured talks. Functional English: Greetings and leave takings.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions.

Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary Analogies (20 words) (Antonyms and Synonyms, Word applications)

Grammar: Use of articles and zero article; prepositions.

Pronunciation: Past tense markers, word stress-di-syllabic words

Unit III:

Lesson-1: Stephen Hawking-Positivity 'Benchmark' from "**Infotech English**", Maruthi Publications

Lesson-2: Shakespeare's Sister by Virginia Woolf from "**The Individual Society",** Pearson Publications. (Non-detailed**)**

Listening: Listening for global comprehension and summarizing what is listened to, both in speaking and writing.

Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed. Functional English: Complaining and Apologizing.

Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension. Critical reading.

Reading for Writing: Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. Letter writing-types, format and principles of letter writing. E-mail etiquette, Writing CV's.

Vocabulary: Technical vocabulary from across technical branches (20 words). GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Association, sequencing of words

Grammar: Verbs - tenses; subject-verb agreement; direct and indirect speech, reporting verbs for academic purposes.

Pronunciation: word stress-poly-syllabic words

Unit IV:

Lesson-1: Liking a Tree, Unbowed: Wangari Maathai-biography from "**Infotech English**", Maruthi Publications

Lesson-2: Telephone Conversation-Wole Soyinka from "**The Individual Society",** Pearson Publications**.** (Non-detailed)

Listening: Making predictions while listening to conversations/ transactional dialogues without video (only audio); listening to audio-visual texts.

Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions. Functional English: Permissions, Requesting, Inviting.

Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicative process or display complicated data.

Reading for Writing: Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables. Writing SOP, writing for media.

Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Cloze Encounters.

Grammar: Quantifying expressions - adjectives and adverbs; comparing and contrasting; degrees of comparison; use of antonyms

Pronunciation: Contrastive Stress

Unit V:

Lesson-1: Stay Hungry-Stay foolish from "**Infotech English**", Maruthi Publications

Lesson-2: Still I Rise by Maya Angelou from "**The Individual Society",** Pearson Publications. (Non-detailed)

Listening: Identifying key terms, understanding concepts and interpreting the concepts both in speaking and writing.

Speaking: Formal oral presentations on topics from academic contexts - without the use of PPT slides. Functional English: Suggesting/Opinion giving.

Reading: Reading for comprehension. RAP Strategy Intensive reading and Extensive reading techniques.

Reading for Writing: Writing academic proposals- writing research articles: format and style.

Vocabulary: Technical vocabulary from across technical branches (20 words) GRE Vocabulary (20 words) (Antonyms and Synonyms, Word applications) Coherence, matching emotions.

Grammar: Editing short texts – identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

Pronunciation: Stress in compound words

Course Outcomes:

At the end of the module, the learners will be able to

- understand social or transactional dialogues spoken by native speakers of English and identify the context, topic, and pieces of specific information
- ask and answer general questions on familiar topics and introduce oneself/others
- employ suitable strategies for skimming and scanning to get the general idea of a text and locate specific information
- recognize paragraph structure and be able to match beginnings/endings/headings with paragraphs
- form sentences using proper grammatical structures and correct word forms

Prescribed text books:

1. "Infotech English", Maruthi Publications. (Detailed)

2. "The Individual Society", Pearson Publications. (Non-detailed)

Prescribed text book for Laboratory for Semesters-I & II:

1. "Infotech English", Maruthi Publications. (with Compact Disc)

Reference Books

- Bailey, Stephen. *Academic writing: A handbook for international students*. Routledge, 2014.
- Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking.* Heinley ELT; 2nd Edition, 2018.
- Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
- Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012.

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B.Tech I Year I Semester

L	T	P	C
3	0	0	3

Calculus
(Common to ALL branches)

Course Objectives:

- This course will illuminate the students in the concepts of calculus.
- To enlighten the learners in the concept of differential equations and multivariable calculus.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

UNIT I: Sequences, Series and Mean value theorems: (10 hrs)

Sequences and Series: Convergences and divergence – Ratio test – Comparison tests – Integral test – Cauchy's root test – Alternate series – Leibnitz's rule.

Mean Value Theorems (without proofs): Rolle's Theorem – Lagrange's mean value theorem – Cauchy's mean value theorem – Taylor's and Maclaurin's theorems with remainders.

UNIT II: Differential equations: (15 hrs)

Linear differential equations – Bernoulli's equations – Exact equations and equations reducible to exact form – Non-homogeneous equations of higher order with constant coefficients with non-homogeneous term of the type e^{ax}, sin ax, cos ax, polynomials in x^n, e^{ax} V(x) and x^nV(x) – Method of Variation of parameters

Applications: Orthogonal trajectories – Electrical circuits (RL, RC, RLC) – Simple Harmonic motion.

UNIT III: Partial differentiation: (10 hrs)

Introduction – Homogeneous function – Euler's theorem – Total derivative – Chain rule – Jacobian – Functional dependence – Taylor's and Mc Laurent's series expansion of functions of two variables.

Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method (with constraints).

UNIT IV: Multiple integrals: (8 hrs)

Double and Triple integrals – Change of order of integration – Change of variables.

Applications: Finding Areas and Volumes.

UNIT V: Special functions: (5 hrs)

Introduction to Improper Integrals-Beta and Gamma functions- Properties - Relation between Beta and Gamma functions- Evaluation of improper integrals.

Course Outcomes:

At the end of the course, the student will be able to

- utilize mean value theorems to real life problems
- solve the differential equations related to various engineering fields
- familiarize with functions of several variables which is useful in optimization
- Apply double integration techniques in evaluating areas bounded by region
- students will also learn important tools of calculus in higher dimensions. Students will become

  familiar with 2- dimensional and 3-dimensional coordinate systems
- Conclude the use of special function in multiple integrals

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.

Reference Books:

1. **B. V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.
2. **Joel Hass, Christopher Heil and Maurice D. Weir,** Thomas calculus, 14th Edition, Pearson.
3. **Lawrence Turyn,** Advanced Engineering Mathematics, CRC Press, 2013.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford University Press.

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L	T	P	C
3	0	0	3

ENGINEERING CHEMISTRY

(For Non-circuital branches CE, ME & MET)

Knowledge of basic concepts of Chemistry for Engineering students will help them as professional engineers later in design and material selection, as well as utilizing the available resources.

Course Objectives:

- ***Importance*** of usage of plastics in household appliances and composites (FRP) in aerospace and automotive industries.
- ***Outline*** the basics for the construction of electrochemical cells, batteries and fuel cells. Understand the mechanism of corrosion and how it can be prevented.

  Express the increase in demand as wide variety of advanced materials are introduced; which have excellent engineering properties.

  Classify and discuss the materials used in major industries like steel industry, metallurgical industries and construction industries and electrical equipment manufacturing industries. Lubrication is also ***summarized***.
- ***Relate*** the need of fuels as a source of energy to any industry, particularly industries like thermal power stations, steel industry, fertilizer industry etc., and hence introduced.
- ***Explain*** the importance and usage of water as basic material in almost all the industries; ***interpret*** drawbacks of steam boilers and also how portable water is supplied for drinking purposes.

UNIT I: POLYMER TECHNOLOGY

Polymerisation:- Introduction-methods of polymerization (emulsion and suspension)-physical and mechanical properties.

Plastics: Compounding-fabrication (compression, injection, blown film, extrusion) - preparation, properties and applications of PVC, polycarbonates and Bakelite-mention some examples of plastic materials used in electronic gadgets, recycling of e-plastic waste.

Elastomers:- Natural rubber-drawbacks-vulcanization-preparation, properties and applications of synthetic rubbers (Buna S, thiokol and polyurethanes).

Composite materials: Fiber reinforced plastics-conducting polymers-biodegradable polymers-biopolymers-biomedical polymers.

UNIT II: ELECTROCHEMICAL CELLS AND CORROSION

Single electrode potential-Electrochemical series and uses of series-standard hydrogen electrode, calomel electrode-concentration cell-construction of glass electrode-Batteries: Dry cell, Ni-Cd cells, Ni-Metal hydride cells, Li ion battery, zinc air cells–Fuel cells: H_2-O_2, CH_3OH-O_2, phosphoric acid, molten carbonate.

Corrosion:-Definition-theories of corrosion (chemical and electrochemical)-galvanic corrosion, differential aeration corrosion, stress corrosion, waterline corrosion-passivity of metals-galvanic series-factors influencing rate of corrosion-corrosion control (proper designing, cathodic protection)-Protective coatings: Surface preparation, cathodic and anodic coatings, electroplating, electroless plating (nickel). Paints (constituents, functions, special paints).

UNIT III: CHEMISTRY OF MATERIALS

Nano materials:- Introduction-sol-gel method-characterization by BET, SEM and TEM methods-applications of graphene-carbon nanotubes and fullerenes:Types, preparation and applications

Thermal analysis techniques: Instrumentation and applications of thermogravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC).

Refractories: **-** Definition, classification, properties (refractoriness, refractoriness under load, porosity and thermal spalling), failure of refractories.

Lubricants: **-** Definition, mechanism of lubricants and properties (definition and importance).

Cement: **-** Constituents, manufacturing, parameters to characterize the clinker formation: lime saturation factor (LSF), silica ratio (SR) and alumina ratio (AR), chemistry of setting and hardening, deterioration of cement.

UNIT IV: FUELS

Introduction-calorific value-HCV and LCV-problems using Dulong's formula-proximate and ultimate

analysis of coal sample-significance of these analyses-problems-Petroleum (refining-cracking)-Synthetic petrol (Fischer Tropsch and Bergius)-petrol knocking-diesel knocking-octane and cetane ratings-anti-knock agents-Introduction to alternative fuels (Bio-diesel, ethanol, methanol, Natural gas, LPG, CNG)-Flue gas analysis by Orsat apparatus-Rocket fuels.

UNIT V: WATER TECHNOLOGY

Hardness of water-determination of hardness by complexometric method-boiler troubles (priming and foaming, scale formation, boiler corrosion, caustic embrittlement)-internal treatments-softening of hard water (zeolite processs and related sums, ion exchange process)-treatment of industrial waste water Portable water and its specifications-steps involved in purification of water-chlorination, break point chlorination-reverse osmosis and electro dialysis.

Learning Outcomes: ***At the end of the course, the students will be able to***

- ***Outline*** preparation, properties and applications of some plastic materials and synthetic rubber explain the mechanism of conduction in conducting polymers.
- ***Explain*** the theory of construction of battery, fuel cells and categorize the reasons for corrosion and study some methods of corrosion control.
- ***Outline*** the awareness of materials like nanomaterials, fullerenes, refractories and lubricants.
- ***Differentiate*** petroleum, petrol, synthetic petrol, study alternate fuels and flue gases.
- ***Explain*** the impurities present in raw water, problems associated with them and how to avoid them are understood.

Text Books:

1. Engineering Chemistry by Jain and Jain; Dhanpat Rai Publicating Co. Latest edition
2. Engineering Chemistry by Shikha Agarwal; Cambridge University Press, 2019 edition.

Reference Books:

1. A text book of engineering Chemistry by S. S. Dara; S. Chand & Co Ltd., Latest Edition
2. Engineering Chemistry by Shashi Chawla; Dhanpat Rai Publicating Co. Latest edition

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B.Tech I Year I Semester

L	T	P	C
3	0	0	3

Problem Solving and Programming Using C

Course Objectives:

1. To impart adequate knowledge on the need of programming languages and problem solving techniques and develop programming skills.
2. To enable effective usage of Control Structures and Implement different operations on arrays.
3. To demonstrate the use of Strings and Functions.
4. To impart the knowledge of pointers and understand the principles of dynamic memory allocation.
5. To understand structures and unions and illustrate the file concepts and its operations.
6. To impart the Knowledge Searching and Sorting Techniques.

UNIT-I

Introduction to Computer Problem Solving: Programs and Algorithms, Computer Problem Solving Requirements, Phases of Problem Solving, Problem Solving Strategies, Top-Down Approach, Algorithm Designing, Program Verification, Improving Efficiency, Algorithm Analysis and Notations.

UNIT-II

Introduction to C Programming: Introduction, Structure of a C Program, Comments, Keywords, Identifiers, Data Types, Variables, Constants, Input/output Statements, Operators, Type Conversion.
Control Flow, Relational Expressions: Conditional Branching Statements: if, if-else, if-else–if, switch. Basic Loop Structures: while, do-while loops, for loop, nested loops, The Break and Continue Statements, goto statement.

UNIT-III

Arrays: Introduction, Operations on Arrays, Arrays as Function Arguments, Two dimensional Arrays, Multi dimensional arrays.
Pointers: Concept of a Pointer, Declaring and Initializing Pointer Variables, Pointer Expressions and Address Arithmetic, Null Pointers, Generic Pointers, Pointers as Function Arguments, Pointers and Arrays, Pointer to Pointer, Dynamic Memory Allocation, Dangling Pointer, Command Line Arguments.

UNIT-IV

Functions: Introduction, Function Declaration, Function Definition, Function Call, Categories of Functions, Passing Parameters to Functions, Scope of Variables, Variable Storage Classes, Recursion.

Strings: String Fundamentals, String Processing with and without Library Functions, Pointers and Strings.

UNIT-V

Structures, Unions, Bit Fields: Introduction, Nested Structures, Arrays of Structures, Structures and Functions, Self-Referential Structures, Unions, Enumerated Data Type –enum variables, Using Typedef keyword, Bit Fields.

Data Files: Introduction to Files, Using Files in C, Reading from Text Files, Writing to Text Files, Random File Access.

Course Outcomes:

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

1. Illustrate the Fundamental concepts of Computers and basics of computer programming.
2. Use Control Structures and Arrays in solving complex problems.
3. Develop modular program aspects and Strings fundamentals.
4. Demonstrate the ideas of pointers usage.
5. Solve real world problems using the concept of Structures, Unions and File operations.

Text Books:

1. How to solve it by Computer, R. G. Dromey, and Pearson Education.
2. Computer Programming, Reema Thareja, Oxford University Press.

Reference Books:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
2. Programming In C A-Practial Approach, Ajay Mittal, Pearson.
3. C Programming – A Problem Solving Approach, Forouzan, Gilberg, Cengage.
4. The C Programming Language, Dennis Richie And Brian Kernighan, Pearson Education.
5. Programming In C, Ashok Kamthane, Second Edition, Pearson Publication.
6. Let us C , Yaswanth Kanetkar, 16th Edition,BPB Publication.

Web Links:

1. http://www.c4learn.com/
2. http://www.geeksforgeeks.org/c/
3. http://nptel.ac.in/courses/122104019/
4. http://www.learn-c.org/
5. https://www.tutorialspoint.com/cprogramming.

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B.Tech I Year I Semester

L	T	P	C
1	0	3	2.5

ENGINEERING GRAPHICS AND DRAFTING

Course Objective: Engineering drawing being the principal method of communication for engineers, the objective is to introduce the students, the techniques of constructing the various types of polygons, curves and scales. The objective is also to visualize and represent the 3D objects in 2D planes with proper dimensioning, scaling etc.

Unit I
Objective: To introduce the students to use drawing instruments and to draw polygons, Engg. Curves.
Polygons: Constructing regular polygons by general methods, inscribing and describing polygons on circles.
Curves: Parabola, Ellipse and Hyperbola by general and special methods, cycloids, involutes, tangents & normals for the curves.
Scales: Plain scales, diagonal scales and vernier scales

Unit II
Objective: To introduce the students to use orthographic projections, projections of points & simple lines. To make the students draw the projections of the lines inclined to both the planes.
Orthographic Projections: Reference plane, importance of reference lines, projections of points in various quadrants, projections of lines, line parallel to both the planes, line parallel to one plane and inclined to other plane.
Projections of straight lines inclined to both the planes, determination of true lengths, angle of inclination and traces.

Unit III
Objective: The objective is to make the students draw the projections of the plane objects/ inclined to both the reference planes.
Projections of planes: regular planes perpendicular/parallel to one reference plane and inclined to the other reference plane; inclined to both the reference planes.

Unit IV
Objective: The objective is to make the students draw the projections of the various types of solids in different positions inclined to one of the planes.

Projections of Solids – Prisms, Pyramids, Cones and Cylinders with the axis inclined to both the planes.

Unit V
Objective: The objective is to represent the object in 3D view through isometric views. The student will be able to represent and convert the isometric view to orthographic view and vice versa.

Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views.
Computer Aided Drafting, Creating 2D&3D drawings of objects using relevant software.
Note: In the End Examination there will be no question from CAD.

TEXT BOOKS:

- Engineering Drawing by N.D. Bhatt, Chariot Publications
- Engineering Drawing by Agarwal & Agarwal, Tata McGraw Hill Publishers

REFERENCE BOOKS:

1. Engineering Drawing by K.L.Narayana & P. Kannaiah, Scitech Publishers
2. Engineering Graphics for Degree by K.C. John, PHI Publishers
3. Engineering Graphics by PI Varghese, McGrawHill Publishers
4. Engineering Drawing + AutoCad – K Venugopal, V. Prabhu Raja, New Age

Course Outcome:

CO1. To make the students to draw the attributes and its importance in the fields of design and manufacturing
CO2. To make the student familiar with the techniques used for drawing various geometric elements used in engineering practice.
CO3. Making them to understand orthographic projections of points, lines, planes and solids in various positions with respect to different reference planes.
CO4. Ability to use the concepts of isometric projections to analyze 3D objects by viewing their 2D projections and vice versa.

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L	T	P	C
0	0	3	1.5

English Communicative Skills Lab-I
(Common to all Branches)

UNIT I:

Pronunciation-Vowels, Consonants

Oral Activity: JAM

UNIT II:

Pronunciation: Consonants

Oral Activity: Past tense markers

UNIT III:

Pronunciation: Word Stress

Oral Activity: Hypothetical Situations

UNIT IV:

Pronunciation: Disyllabic words, polysyllabic words

Oral Activity: Self /Peer profile

UNIT V: Common Errors in Pronunciation
Neutralizing Accent

Prescribed text book: Phonetic Transcription

1. "**Infotech English**", Maruthi Publications.

References Books :

1. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
2. English Pronunciation in use- Mark Hancock, Cambridge University Press.
3. English Phonetics and Phonology-Peter Roach, Cambridge University Press.
4. English Pronunciation in use- Mark Hewings, Cambridge University Press.
5. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
6. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.

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0	0	3	1.5

ENGINEERING CHEMISTRY LAB

(For Non-circuital branches CE, ME & MET)

Introduction to Chemistry laboratory – Molarity, normality, primary, secondary standard solutions,
volumetric titrations, quantitative analysis

1. Determination of HCl using standard Na_2CO_3 solution.
2. Determination of alkalinity of a sample containing Na_2CO_3 and NaOH.
3. Determination of Mn (II) using standard oxalic acid solution.
4. Determination of ferrous iron using standard $K_2Cr_2O_7$ solution.
5. Determination of copper (II) using standard hypo solution.
6. Determination of temporary and permanent hardness of water using standard EDTA solution.
7. Determination of iron (III) by a colorimetric method.
8. Determination of the concentration of acetic acid using sodium hydroxide (pH-metry method).
9. Determination of the concentration of strong acid vs strong base (by conductometric method).
10. Determination of strong acid vs strong base (by potentiometric method).
11. Determination of Mg^{+2} present in an antacid.
12. Determination of $CaCO_3$ present in an egg shell.
13. Estimation of Vitamin C.
14. Determination of % moisture and % volatile matter in coal sample by proximate analysis.
15. Preparation of biodiesel.
16. Preparation of nylon-6, 6 and Bakelite (demonstration only).

Of the above experiments at-least 10 assessment experiments should be completed in a semester.

Outcomes: The students entering into the professional course have practically very little exposure to lab classes. The experiments introduce volumetric analysis; redox titrations with different indicators; EDTA titrations; then they are exposed to a few instrumental methods of chemical analysis. Thus at the end of the lab course, the student is exposed to different methods of chemical analysis and use of some commonly employed instruments. They thus acquire some experimental skills.

Reference Books

1. A Textbook of Quantitative Analysis, Arthur J. Vogel.

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L	T	P	C
0	0	3	1.5

MECHANICAL WORKSHOP PRACTICE

Course Objective: To impart hands-on practice on basic engineering trades and skills.

Note: At least two exercises to be done from each trade.
Trade:

1.Carpentry	1. T-Lap Joint 2. Cross Lap Joint 3. Dovetail Joint 4. Mortise and Tenon Joint
2.Fitting	1. Vee Fit 2. Square Fit 3. Half Round Fit 4. Dovetail Fit
3.Black Smithy	1. Round rod to Square 2. S-Hook 3. Round Rod to Flat Ring 4. Round Rod to Square headed bolt
4.House Wiring	1. Parallel / Series Connection of three bulbs 2. Stair Case wiring 3. Florescent Lamp Fitting 4. Measurement of Earth Resistance
5.Tin Smithy	1. Taper Tray 2. Square Box without lid 3. Open Scoop 4. Funnel
6. IT Workshop	1.Assembly & Disassembly of Computer

Course Outcomes:
CO1. Able to understand the basic engineering trades
CO2. Able to analyze working of various tools
CO3.Able to understand the basic hardware of computer

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	L	T	P	C
B.Tech I Year I Semester	**0**	**0**	**3**	**1.5**

Problem Solving and Programming Using C Lab

Course Objectives:

1. To impart knowledge on basic Linux commands, various Editors, Raptor.
2. To make the students understand the concepts of C programming.
3. To nurture the students on Control Structures and develop different operations on arrays.
4. To make use of String fundamentals and modular programming constructs.
5. To implement programs using dynamic memory allocation.
6. To explain the concepts of Structure, Unions and files for solving various problems.

List of Experiments:

1. Introduction to Algorithms and Flowcharts

1.1) Implement Algorithm Development for Exchange the values of Two numbers.

1.2) Given a set of n student's examination marks (in the range 0-100) make a count of the number of students that passed the examination. A Pass is awarded for all of 50 and above.

1.3) Given a set of n numbers design an algorithm that adds these numbers and returns the resultant sum. Assume N is greater than or equal to zero.

2. Introduction to C Programming

2.1) Basic Linux Commands.

2.2) Exposure to Turbo C, Vi, Emacs, Code Blocks IDE, Dev C++.

2.3) Writing simple programs using printf(), scanf() .

3. Raptor

3.1) Installation and Introduction to Raptor.

3.2) Draw a flow chart to find the Sum of 2 numbers.

3.3) Draw a flow chart to find Simple interest.

4. Basic Math

4.1) Write a C Program to convert Celsius to Fahrenheit and vice versa.

4.2) Write a C Program to find largest of three numbers using ternary operator.

4.3) Write a C Program to Calculate area of a Triangle using Heron's formula.

5. Control Flow- I

5.1) Write a C Program to Find Whether the Given Year is a Leap Year or not.
5.2) Write a C program to find the roots of a Quadratic Equation.
5.3) Write a C Program to make a simple Calculator to Add, Subtract, Multiply or Divide Using Switch…case.

6. Control Flow- II

6.1) Write a C Program to Find Whether the Given Number is Prime number or not.
6.2) Write a C Program to Find Whether the Given Number is Armstrong Number or not.
6.3) Write a C program to print Floyd Triangle.

7. Control Flow- III

7.1) Write a C program to find the sum of individual digits of a positive integer.
7.2) Write a C program to check whether given number is palindrome or not.
7.3) Write a C program to read two numbers, x and n, and then compute the sum of the geometric progression $1+x+x^2+x^3+\ldots\ldots\ldots\ldots+x^n$.

8. Arrays

8.1) Write a C program to search an element in the given array (Linear Search).
8.2) Write a C program to perform matrix addition.
8.3) Write a C program to perform matrix multiplication.

9. Pointers

9.1) Write a C Program to Perform Addition, Subtraction, Multiplication and Division of two numbers using Command line arguments.
9.2) Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc () function.
9.3) Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc () function.

10. Functions, Array & Pointers

10.1) Write a C Program to demonstrate parameter passing in Functions.
10.2) Write a C Program to find Fibonacci, Factorial of a number with Recursion and without recursion.
10.3) Write a C Program to find the sum of given numbers with arrays and pointers.

11. Strings

11.1) Implementation of string manipulation operations with library function:
a) copy
b) concatenate
c) length
d) compare

11.2) Implementation of string manipulation operations without library function:
a) copy
b) concatenate
c) length
d) compare
11.3) Verify whether the given string is a palindrome or not.

12. Structures

12.1) Write a C Program to Store Information of a book Using Structure.
12.2) Write a C Program to Add Two Complex Numbers by Passing Structure to a Function.

13. Files

13.1) Write a C program to open a file and to print the contents of the file on screen.
13.2) Write a C program to copy content of one file to another file.
13.3) Write a C program to merge two files and store content in another file.

14. Application

Creating structures to capture the student's details save them in file in proper record format, search
and prints the student details requested by the user.

Note: Draw the flowcharts using Raptor from Experiment 3 to Experiment 6.

Course Outcomes:

- Implement basic programs in C and design flowcharts in Raptor.
- Use Conditional and Iterative statements to solve real time scenarios in C.
- Implement the concept of Arrays and Modularity and Strings.
- Apply the Dynamic Memory Allocation functions using pointers.
- Develop programs using structures, and Files.

Reference Books:

1. Let Us C Yashwanth Kanetkar, 16th edition, BPB Publications.
2. Programming in C A-Practial Approach Ajay Mittal. Pearson Education.
3. The C programming Language, Dennis Richie and Brian Kernighan, Pearson Education.
4. Problem solving using C , K Venugopal,3rd Edition,TMG Publication.

Web Links:

1. https://www.hackerrank.com/
2. https://www.codechef.com/
3. https://www.topcoder.com/
4. https://code-cracker.github.io/
5. https://raptor.martincarlisle.com/
6. https://nptel.ac.in/courses/106105085/2

UNIVERSITY COLLEGE OF ENGINEERING VIZAINAGARAM (Autonomous)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

B.Tech I Year I Semester

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Constitution of India
(Common to All Branches)

Course Objectives:

- To Enable the student to understand the importance of constitution
- To understand the structure of executive, legislature and judiciary
- To understand philosophy of fundamental rights and duties
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and election commission of India.
- To understand the central and state relation financial and administrative.

UNIT-I

Introduction to Indian Constitution: Constitution meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

UNIT-II

Union Government and its Administration Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, LokSabha, RajyaSabha, The Supreme Court and High Court: Powers and Functions;

UNIT-III

State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

UNIT-IV

Local Administration - District's Administration Head - Role and Importance, Municipalities – Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions PRI: ZilaPanchayat, Elected officials and their roles, CEO ZilaPanchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

UNIT-V

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission:, Functions of Commissions for the welfare of SC/ST/OBC and women

Course Outcomes:

At the end of the semester/course, the student will be able to have a clear knowledge on the following:

- Understand historical background of the constitution making and its importance for building a democratic India.
- Understand the functioning of three wings of the government ie., executive, legislative and judiciary.
- Understand the value of the fundamental rights and duties for becoming good citizen of India.
- Analyze the decentralization of power between central, state and local self-government.
- Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.
    1. Know the sources, features and principles of Indian Constitution.
    2. Learn about Union Government, State government and its administration.
    3. Get acquainted with Local administration and Pachayati Raj.
    4. Be aware of basic concepts and developments of Human Rights.
    5. Gain knowledge on roles and functioning of Election Commission

References Books:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd.. New Delhi
2. SubashKashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government andPolitics Hans
7. J. Raj IndianGovernment and Politics

8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

E-resources:

1. nptel.ac.in/courses/109104074/8
2. nptel.ac.in/courses/109104045/
3. nptel.ac.in/courses/101104065/
4. www.hss.iitb.ac.in/en/lecture-details
5. www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution

UNIVERSITY COLLEGE OF ENGINEERING VIZIAINAGARAM (Autonomous)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

B.Tech I Year II Semester

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Linear algebra and Numerical Methods
(Common to ALL branches)

Course Objectives:

- To instruct the concept of Matrices in solving linear algebraic equations
- To elucidate the different numerical methods to solve nonlinear algebraic equations
- To disseminate the use of different numerical techniques for carrying out numerical integration.
- To equip the students with standard concepts and tools at an intermediate to advanced level mathematics to develop the confidence and ability among the students to handle various real world problems and their applications.

Unit I: Solving systems of linear equations, Eigen values and Eigen vectors: (10 hrs)

Rank of a matrix by echelon form and normal form- Gauss Jordan method to find inverse – Solving system of homogeneous and non-homogeneous equations linear equations — Eigen values and Eigen vectors and their properties.
Applications: Free vibration of a two-mass system.

Unit-II: Cayley-Hamilton theorem and Quadratic forms: (10 hrs)

Cayley-Hamilton theorem (without proof) – Finding inverse and power of a matrix by Cayley-Hamilton theorem – Reduction to Diagonal form – Quadratic forms and nature of the quadratic forms – Reduction of quadratic form to canonical forms by orthogonal transformation.

UNIT III: Iterative methods: (8 hrs)

Introduction – Algebraic transcendental equations: Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method (One variable and simultaneous Equations)

Solving system of linear equations: Gauss elimination- Diagonal dominance- Jacobi and Gauss-Seidel methods– Necessary and sufficient condition for convergence(only statement)- Power Method for finding Largest Eigenvalue –Eigenvector.

UNIT IV: Interpolation: (10 hrs)

Introduction – Errors in polynomial interpolation – Finite differences – Forward differences – Backward differences – Central differences – Relations between operators – Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula – Newton's divide difference formula.

UNIT V: Numerical integration and solution of ordinary differential equations:(10 hrs)

Trapezoidal rule – Simpson's $1/3^{rd}$ and $3/8^{th}$ rule – Solution of ordinary differential equations by Taylor's series – Picard's method of successive approximations – Euler's method – Runge-Kutta method (second and fourth order) – Milne's Predictor and Corrector Method.

Course Outcomes:

At the end of the course, the student will be able to

- develop the use of matrix algebra techniques that is needed by engineers for practical applications
- solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss Seidel
- evaluate approximating the roots of polynomial and transcendental equations by different algorithms
- apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals
- apply different algorithms for approximating the solutions of ordinary differential equations to its analytical computations

Text Books:

1. **M. K. Jain, S. R. K. Iyengar and R. K. Jain,** Numerical Methods for Scientific and Engineering Computation, New Age International Publications.
2. **B. S. Grewal,** Higher Engineering Mathematics, 43^{rd} Edition, Khanna Publishers.

Reference Books:

1. **B. V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.
2. **David Poole,** Linear Algebra- A modern introduction, 4^{th} Edition, Cengage.
3. **Steven C. Chapra,** Applied Numerical Methods with MATLAB for Engineering and Science, Tata Mc. Graw Hill Education.

Lawrence Turyn, Advanced Engineering Mathematics, CRC Press.

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B.Tech I Year II Semester

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ENGINEERING PHYSICS

For Non-Circuital Branches (CE, ME & MET)

The designed curriculum introduces the fundamentals of elasticity, sensors, and mechanics of solids to CE, ME and MET students so as to acquaint them with the behavior of materials and develop a basic understanding of the advanced courses in their respective branches.

Course Objectives:

- **To demonstrate** the use of Newton's laws of motion for understanding the mechanics of a particle.
- **Tap** the simple harmonic motion and its adaptability for improved acoustic quality of concert halls-impart concepts of flaw detection techniques using ultrasonics.
- **Study** the structure – property relationship exhibited by solid materials within the elastic limit. **Impart** knowledge basic concepts of lasers and fibre optics along with its engineering applications
- **Familiarize** types of sensors for various engineering applications.
- **To impart** knowledge concerning the electrical behaviour of dielectric materials.
- To **demonstrate** the properties of magnets.

UNIT-I: Mechanics **(10hrs)**

Basic Laws of Vectors and Scalars - Rotational Frames - Conservative and Non – Conservative Forces - F = - grad V - Newton's Laws in Inertial and Linear Accelerating Non – Inertial Frames of Reference - Rotating Frame of Reference with Constant Angular Velocity - Harmonic Oscillator - Damped Harmonic Motion - Forced Oscillations and Resonance - Quality Factor - Mechanical and Electrical Oscillators.

UNIT-II: Acoustics and Ultrasonics **(9hrs)**

Acoustics: Reverberation - Reverberation Time - Sabine's Formula (Derivation using Growth and Decay Method) - Absorption Coefficient and its Determination - Factors Affecting Acoustics of Buildings and their Remedies.
Ultrasonics: Production of Ultrasonics by Magnetostriction and Piezoelectric Methods - Acoustic Grating - Non–Destructive Testing - Pulse Echo System through Transmission and Reflection Modes - Applications.

UNIT-III: Elasticity and Sensors (**10hrs)**

Elasticity: Stress - Strain - Hooke's Law - Stress – Strain Curve - Generalized Hooke's Law with and without Thermal Strains for Isotropic Materials - Different Types of Moduli and their Relations - Bending of Beams - Bending Moment of a Beam - Depression of Cantilever.

Sensors (Qualitative Description Only): Different Types of Sensors and Applications - Strain and Pressure Sensors - Piezoelectric, Magnetostrictive Sensors - Temperature Sensor - Bimetallic Strip - Fibre Optic Methods of Pressure Sensing - Pyroelectric Detectors.

UNIT-IV: Lasers and Fiber Optics (**9hrs)**

Lasers: Characteristics - Spontaneous and Stimulated Emission of Radiation - Einstein's Coefficients - Population Inversion - Pumping Mechanisms - Ruby Laser - Helium Neon Laser - Applications.

Fibre Optics: Total Internal Reflection - Acceptance Angle - Numerical Aperture - Classification of Fibers Based on Refractive Index Profile and Modes - Block Diagram of Fiber Optic Communication.

UNIT-V: Magnetic and Dielectric Materials (**10 hrs)**

Magnetic Materials: Introduction - Magnetic Dipole Moment - Magnetization - Magnetic Susceptibility and Permeability - Origin of Permanent Magnetic Moment - Classification of Magnetic Materials - Domain Concept of Ferromagnetism - Hysteresis - Soft and Hard Magnetic Materials.

Dielectric Materials: Introduction - Dielectric Polarization - Dielectric Polarizability - Susceptibility and Dielectric Constant - Electronic and Ionic Polarizations (Quantitative) - Orientation Polarization (Qualitative) - Lorentz Field - Claussius – Mossotti Equation - Frequency Dependence of polarization.

Course Outcomes:

The students will be able to

- **describe** the fundamental principles of acoustics with emphasis on physical mechanisms, law and relationships
- **assess** harmonic motion in undamped, damped and forced oscillations
- **apply** the concepts of strain, internal force, stress and equilibrium to deformation of solids
- **understand** the interaction of radiation with matter
- **explain** the principles of physics in dielectrics, magnetic materials and semiconductors useful to engineering applications
- **illustrate** the fibre optic methods of pressure sensing and **infer** the functioning of temperature sensors like bimetallic strip and pyroelectric detectors
- **outline** the basic principle and operation of different types of *sensors*

Text books:

1. M.N. Avadhanulu, P.G.Kshirsagar "A Text book of Engineering Physics", 11th ed. S. Chand Publications, 2019
2. S.O. Pillai, Solid State Physics 8th ed., New Age International, 2018

Reference Books:

1. D. Kleppner and Robert Kolenkow "An introduction to Mechanics– II" Cambridge University Press, 2015
2. A Textbook of Engineering Physics, Volume-I (For 1st Year of Anna University) By M.N. Avadhanulu & T.V.S. Arun Murthy S Chand
3. Ian R Sinclair, Sensor and Transducers 3rd eds, 2001, Elsevier (Newnes)

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B.Tech I Year II Semester

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ENIGINEERING MECHANICS

Objectives: The students completing this course are expected to understand the concepts of forces and its resolution in different planes, resultant of force system, Forces acting on a body, their free body diagrams using graphical methods. They are required to understand the concepts of centre of gravity and moments of inertia and their application, Analysis of frames and trusses, different types of motion, friction and application of work - energy method.

UNIT – I

Introduction to Engg. Mechanics – Basic Concepts.

Systems of Forces: Coplanar Concurrent Forces – Components in Space – Resultant – Moment of Force and its Application – Couples and Resultant of Force Systems.

Friction: Introduction**,** limiting friction and impending motion, coulomb's laws of dry friction, coefficient of friction, cone of friction

UNIT II

Equilibrium of Systems of Forces: Free Body Diagrams, , Lami's Theorm, Equations of Equilibrium of Coplanar Systems, Graphical method for the equilibrium, Triangle law of forces, converse of the law of polygon of forces condition of equilibrium, Equations of Equilibrium for Spatial System of forces, Numerical examples on spatial system of forces using vector approach, Analysis of plane trusses.

UNIT – III

Centroid: Centroids of simple figures (from basic principles) – Centroids of Composite Figures

Centre of Gravity: Centre of gravity of simple body (from basic principles), centre of gravity of composite bodies, Pappus theorems.

Area moments of Inertia: Definition – Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia. **Mass Moment of Inertia:** Moment of Inertia of Masses, Transfer Formula for Mass Moments of Inertia, mass moment of inertia of composite bodies.

UNIT – IV

Rectilinear and Curvilinear motion of a particle: Kinematics and Kinetics- D'Alembert's Principle, Work Energy method and applications to particle motion- Impulse momentum method.

UNIT – V

Rigid body Motion: Kinematics and kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse momentum method.

TEXT BOOK:

1. Engg. Mechanics - S.Timoshenko & D.H.Young., 4th Edn - , Mc Graw Hill publications.

REFERENCES:

1. Engineering Mechanics statics and dynamics – R.C.Hibbeler, 11th Edn – Pearson Publ.
2. Engineering Mechanics , statics – J.L.Meriam, 6th Edn – Wiley India Pvt Ltd.
3. Engineering Mechanics , dynamics – J.L.Meriam, 6th Edn – Wiley India Pvt Ltd.
4. Engineering Mechanics , statics and dynamics – I.H.Shames, – Pearson Publ.
5. Mechanics For Engineers , statics - F.P.Beer & E.R.Johnston – 5th Edn Mc Graw Hill Publ.
6. Mechanics For Engineers, dynamics - F.P.Beer & E.R.Johnston –5th Edn Mc Graw Hill Publ.
7. Theory & Problems of engineering mechanics, statics & dynamics – E.W.Nelson, C.L.Best & W.G. McLean, 5th Edn – Schaum's outline series - Mc Graw Hill Publ.
8. Engineering Mechanics , Fedinand . L. Singer , Harper – Collins.
9. Engineering Mechanics statics and dynamics , A Nelson , Mc Graw Hill publications
10. Engineering Mechanics, Tayal. Umesh Publ.

Course outcomes:

CO1. To Learn the principles (Axioms) of statics, able to find resultant & resolution of system of forces and resultant force.
CO2. Explore the concepts of constraints, free body diagram and action-reaction.
CO3. Estimate the geometric parameters like centroid, center of gravity and moment of inertia and identify their application.
CO4. Learn the analysis of frames and trusses and know the importance of friction.
CO5. Able to determine solution to dynamic problems through D'Alembert equilibrium equations, Impulse-Momentum and work– energy method

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B.Tech I Year II Semester

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3	0	0	3

Basic Electrical And Electronics Engineering
(Common for Civil,MEC,MET Engg.)

Preamble:
This course covers the topics related to analysis of various electrical circuits, operation of various electrical machines and electronic components to perform well in their respective fields.

Course objectives:

- To learn the basic principles of electrical circuital law's and analysis of networks.
- To understand principle of operation and construction details of DC machines & Transformers.
- To understand principle of operation and construction details of alternator and 3-Phase induction motor.
- To study operation of PN junction diode, half wave, full wave rectifiers and OP-AMPs.
- To learn operation of PNP and NPN transistors and various amplifiers.

Unit - I
Electrical Circuits
Basic definitions – types of network elements – Ohm's Law – Kirchhoff's Laws – inductive networks – capacitive networks – series – parallel circuits – star-delta and delta-star transformations-Numerical Problems.

Unit - II
DC Machines
Principle of operation of DC generator – EMF equation – types of DC machines – torque equation – applications – three point starter – speed control methods of DC motor – Swinburne's Test-Numerical Problems.

Unit - III
AC Machines:
Transformers
Principle of operation and construction of single phase transformers – EMF equation – Losses – OC & SC tests – efficiency and regulation-Numerical Problems.

AC Rotating Machines
Principle of operation and construction of alternators – types of alternators –Regulation of alternator by synchronous impedance method- principle of operation of synchronous motor – principle of operation of 3-Phase induction motor – slip-torque characteristics – efficiency – applications-Numerical Problems.

Unit IV

Rectifiers and Linear ICs and Transistors

PN junction diodes – diode applications (half wave and bridge rectifiers).Characteristics of operation amplifiers (OP-AMP) – application of OP-AMPs (inverting, non-inverting, integrator and differentiator) -Numerical Problems.

Unit V

Transistors

PNP and NPN junction transistor, transistor as an amplifier – transistor amplifier – frequency response of CE amplifier – concepts of feedback amplifier-Numerical Problems.

Course Outcomes:

The student should be able to:

- Analyse various electrical networks.
- Understand operation of DC generators,3-point starter and DC machine testing by Swinburne's Test.
- Analyse performance of single-phase transformer.
- Explain operation of 3-phase alternator and 3-phase induction motors.
- Analyse operation of half wave, full wave bridge rectifiers and OP-AMPs and Explain single stage CE amplifier and concept of feedback amplifier.
-

Text Books:

1. Electrical Technology by Surinder Pal Bali, Pearson Publications.
2. Electronic Devices and Circuits by R.L. Boylestad and Louis Nashelsky, 9th edition, PEI/PHI 2006.

Reference Books:

1. Electrical Circuit Theory and Technology by John Bird, Routledge Taylor &Francis Group
2. Basic Electrical Engineering by M.S.Naidu and S.Kamakshiah, TMH Publications
3. Fundamentals of Electrical Engineering by Rajendra Prasad, PHI Publications,2nd edition
4. Basic Electrical Engineering by Nagsarkar, Sukhija, Oxford Publications,2nd edition
5. Industrial Electronics by G.K. Mittal, PHI.

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B.Tech I Year II Semester

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COMPUTER AIDED ENGINEERING DRAWING

Course Objective: To enhance the student's knowledge and skills in engineering drawing and to introduce drafting packages and commands for computer aided drawing and modeling.

UNIT-I:
Objective: The knowledge of projections of solids is essential in 3D modeling and animation. The student will be able to draw projections of solids. The objective is to enhance the skills they already acquired in their earlier course in drawing of projection.
PROJECTIONS OF SOLIDS: Projections of Regular Solids inclined to both planes – Auxiliary Views.

UNIT-II:
The knowledge of sections of solids and development of surfaces is required in designing and manufacturing of the objects. Whenever two or more solids combine, a definite curve is seen at their intersection.
SECTIONS OF SOLIDS: Sections and Sectional views of Right Regular Solids – Prism, Cylinder, Pyramid, Cone – Auxiliary views.

DEVELOPMENT AND INTERPENETRATION OF SOLIDS: Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid, Cone and their parts.

UNIT-III:
The intersection of solids also plays an important role in designing and manufacturing. The objective is to impart this knowledge through this topic. A perspective view provides a realistic 3D View of an object. The objective is to make the students learn the methods of Iso and Perspective views.
INTERPENETRATION OF RIGHT REGULAR SOLIDS: Intersection of Cylinder Vs Cylinder, Cylinder Vs Prism, Cylinder Vs Cone, Prism Vs Cone.
PERSPECTIVE PROJECTIONS: Perspective View: Points, Lines, Plane Figures and Simple Solids, Vanishing Point Methods (General Method only).

In part B computer aided drafting is introduced.
UNIT IV:
The objective is to introduce various commands in AutoCAD to draw the geometric entities and to create 2D and 3D wire frame models.
INTRODUCTION TO COMPUTER AIDED DRAFTING: Generation of points, lines, curves, polygons, dimensioning. Types of modeling : object selection commands – edit, zoom, cross hatching, pattern filling, utility commands, 2D wire frame modeling, 3D wire frame modeling,.

UNIT V:
By going through this topic the student will be able to understand the paper-space environment thoroughly.

VIEW POINTS AND VIEW PORTS: view point coordinates and view(s) displayed, examples to exercise different options like save, restore, delete , joint , single option.

UNIT VI:

The objective is to make the students create geometrical model of simple solids and machine parts and display the same as an Isometric, Orthographic or Perspective projection.

COMPUTER AIDED SOLID MODELING: Isometric projections, orthographic projections of isometric projections, Modeling of simple solids, Modeling of Machines & Machine Parts.

TEXT BOOKS :

1. Engineering drawing by N.D Bhatt , Charotar publications.
2. Engineering Graphics, K.C. john, PHI Publications

REFERENCES:

1. Mastering Auto CAD 2013 and Auto CAD LT 2013 – George Omura, Sybex
2. Auto CAD 2013 fundamentals- Elisemoss, SDC Publ.
3. Engineering Drawing and Graphics using Auto Cad – T Jeyapoovan, vikas
4. Engineering Drawing + AutoCAD – K Venugopal, V. Prabhu Raja, New Age
5. Engineering Drawing – RK Dhawan, S Chand
6. Engineering Drawing – MB Shaw, BC Rana, Pearson
7. Engineering Drawing – KL Narayana, P Kannaiah, Scitech
8. Engineering Drawing – Agarwal and Agarwal, Mc Graw Hill
9. Engineering Graphics – PI Varghese, Mc Graw Hill
10. Text book of Engineering Drawing with auto-CAD , K.venkata reddy/B.S . publications.
11. Engineering Drawing with Auto CAD/ James D Bethune/Pearson Publications
12. Engineering Graphics with Auto CAD/Kulkarni D.M, Rastogi A.P, Sarkar A.K/PHI Publications

End Semester examination shall be conducted for **Four** hours with the following pattern:

a) Two hours-Conventional drawing
b) Two hours – Computer Aided Drawing

Course outcomes:

From this course the student is expected to learn
CO1: The concepts of sections and developments of solids
CO2: The formation of layers during intersection of different types of regular solids.
CO3: Basics in AUTO CAD
CO4: To draw the 2D and 3D objects using AUTO CAD

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B.Tech I Year II Semester

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English Communicative Skills Lab-II
(Common to all Branches)

UNIT I:
Pronunciation: Contrastive stress (Homograph)

Oral Activity: Telephone Etiquette

UNIT II:
Pronunciation: Word stress – Weak and Strong forms

Oral Activity :Role plays

UNIT III:
Pronunciation: Phonetics Transcription Oral Activity :Data Interpretation, Oral presentation skills
Oral Activity: Oral presentation Skills

UNIT IV:
Pronunciation: Connected speech (Pausing ,Tempo, Tone, Fluency ,etc..)
Oral Activity: Public Speaking ,Poster Presentation

UNIT V:
Pronunciation: Stress in compound words ,Rhythm and Intonation
Oral Activity: Group discussions: Do's and Don'ts –Types ,Modalities
Interview Skills: Preparatory Techniques, Frequently asked questions, Mock Interviews.

References:
1. Exercises in Spoken English Part 1,2,3,4, OUP and CIEFL.
2. English Pronunciation in use- Mark Hancock, Cambridge University Press.
3. English Phonetics and Phonology-Peter Roach, Cambridge University Press.
4. English Pronunciation in use- Mark Hewings, Cambridge University Press.
5. English Pronunciation Dictionary- Daniel Jones, Cambridge University Press.
6. English Phonetics for Indian Students- P. Bala Subramanian, Mac Millan Publications.
7. Technical Communication- Meenakshi Raman, Sangeeta Sharma, Oxford University Press.
8. Technical Communication- Gajendrea Singh Chauhan, Smita Kashiramka, Cengage Publications.

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B.Tech I Year II Semester

ENGINEERING PHYSICS LAB

(Any 10 of the following listed 15 experiments)

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LIST OF EXPERIMENTS:

1. V-I Characteristics of a PN junction diode
2. Rigidity modulus of a material - Torsional Pendulum
3. LCR- series resonance circuit
4. Young's modulus of the given material bar by uniform bending – Pin and Microscope method
5. Sonometer
6. Wavelength of Laser by diffraction grating
7. V-I Characteristics of a Zener junction diode
8. Magnetic field along the axis of a current carrying coil – Stewart and Gee's apparatus
9. Dielectric Constant of different materials
10. RC circuit – time constant
11. Acceleration due to Gravity and Radius of Gyration - Compound Pendulum.
12. B-H curve
13. Magnetic susceptibility by Gouy's method
14. Velocity of ultrasonics - Acoustic Grating
15. Pressure variation with strain- strain Gauge sensor

UNIVERSITY COLLEGE OF ENGINEERING VIZIANAGARAM (Autonomous)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

B.Tech I Year II Semester

L	T	P	C
0	0	2	0

ENGINEERING PHYSICS VIRTUAL LAB

Virtual Lab Experiments (Engineering Physics)

1. Newton's Second Law of Motion
2. Young's Modulus of The Given Material Bar by Uniform Bending using Pin and Microscope Method
3. Young's Modulus of The Given Material Bar by Non Uniform Bending using Pin and Microscope Method
4. Numerical Aperture and Acceptance Angle - Optical Fiber
5. Beam Divergence and Spot Size of The Given Laser Beam
6. Elastic Constants of a Material Using The Principle of Optical Interference
7. Acoustic Grating
8. Heat Transfer by Natural Convection
9. B-H Curve
10. Compound Pendulum – Symmetric

UNIVERSITY COLLEGE OF ENGINEERING VIZIANAGARAM (Autonomous)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

B.Tech I Year II Semester

L	T	P	C
0	0	3	1.5

BASIC ELECTRICAL & ELECTRONICS ENGINEERING LAB
(Common for Civil,MEC,MET Engg.)

Course objectives:

- To predetermine the efficiency of dc shunt machine using Swinburne's test.
- To predetermine the efficiency and regulation of 1-phase transformer with O.C and S.C tests.
- To obtain performance characteristics of DC shunt motor &3-phase induction motor.
- To find out regulation of an alternator with synchronous impedance method.
- To control speed of dc shunt motor using Armature voltage and Field flux control methods.
- To find out the characteristics of PN junction diode & transistor
- To determine the ripple factor of half wave & full wave rectifiers.

Section A: Electrical Engineering:

The following experiments are required to be conducted as compulsory experiments:

1. Swinburne's test on D.C. Shunt machine (predetermination of efficiency of a given D.C. shunt machine working as motor and generator).
2. OC and SC tests on single phase transformer (predetermination of efficiency and regulation at given power factors).
3. Brake test on 3-phase Induction motor (determination of performance characteristics)
4. Regulation of alternator by Synchronous impedance method.
5. Speed control of D.C. Shunt motor by
   a) Armature Voltage control b) Field flux control method
6. Brake test on D.C. Shunt Motor.

Section B: Electronics Engineering:

The following experiments are required to be conducted as compulsory experiments:

1.PN junction diode characteristics a) Forward bias b) Reverse bias (Cut in voltage and resistance calculations)

2. Transistor CE characteristics (input and output)

3. Half wave rectifier with and without filters.

4. Full wave rectifier with and without filters.

5. CE amplifiers.

6. OP- amp applications (inverting, non inverting, integrator and differentiator)

UNIVERSITY COLLEGE OF ENGINEERING VIZAINAGARAM (Autonomous)
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

B.Tech I Year I or II Semester

L	T	P	C
3	0	0	0

Professional Ethics & Human Values

(Common to All Branches)

Course Objectives:

- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values and Loyalty
- To appreciate the rights of others.
- To create awareness on assessment of safety and risk

Unit I: Human Values:
Morals, Values and Ethics-Integrity-Work Ethic-Service learning – Civic Virtue – Respect for others –Living Peacefully –Caring –Sharing –Honesty -Courage-Cooperation–Commitment – Empathy – Self Confidence Character –Spirituality.
Unit II: Engineering Ethics:
Senses of 'Engineering Ethics-Variety of moral issued –Types of inquiry –Moral dilemmas –Moral autonomy –Kohlberg's theory-Gilligan's theory-Consensus and controversy –Models of professional roles-Theories about right action-Self-interest -Customs and religion –Uses of Ethical theories –Valuing time –Cooperation –Commitment.
Unit III: Engineering as Social Experimentation
Engineering As Social Experimentation –Framing the problem –Determining the facts –Codes of Ethics –Clarifying Concepts –Application issues –Common Ground -General Principles –Utilitarian thinking respect for persons
UNIT IV: Engineers Responsibility for Safety and Risk:
Safety and risk –Assessment of safety and risk –Risk benefit analysis and reducing risk-Safety and the Engineer-Designing for the safety-Intellectual Property rights (IPR).
UINIT V: Global Issues
Globalization –Cross-culture issues-Environmental Ethics –Computer Ethics-Computers as the instrument of Unethical behavior –Computers as the object of Unethical acts –Autonomous-Computers-Computer codes of Ethics –Weapons Development -Ethics and Research –Analyzing Ethical Problems in research.

Course outcomes:

Students will be able to:

- Identify and analyze an ethical issue in the subject matter under investigation or in a relevant field
- Identify the multiple ethical interests at stake in a real-world situation or practice
- Articulate what makes a particular course of action ethically defensible
- Assess their own ethical values and the social context of problems

- Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
- Demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work
- Integrate, synthesize, and apply knowledge of ethical dilemmas and resolutions in academic settings, including focused and interdisciplinary research.

Books:

1. "Engineering Ethics includes Human Values" by M.Govindarajan, S.Natarajan and, V.S.SenthilKumar-PHI Learning Pvt. Ltd-2009
2. "Engineering Ethics" by Harris, Pritchard and Rabins, CENGAGE Learning, India Edition, 2009.
3. "Ethics in Engineering" by Mike W. Martin and Roland Schinzinger –Tata McGraw-Hill–2003.
4. "Professional Ethics and Morals" by Prof.A.R.Aryasri, DharanikotaSuyodhana-Maruthi Publications.
5. "Professional Ethics and Human Values" by A.Alavudeen, R.Kalil Rahman and M. Jayakumaran-LaxmiPublications.
6. "Professional Ethics and Human Values" by Prof.D.R.Kiran-
7. "Indian Culture, Values and Professional Ethics" by PSR Murthy-BS Publication

II- Year I-Semester	MINERAL PROCESSING	L	T	P	C
		3	0	0	3

(Course objective: The course presents the principles and methods of beneficiation of minerals from their ores. It covers the theory and working of various crushers, classifiers and other mineral beneficiation equipment to meet the industrial needs.)

UNIT I

(Learning objective: To study the scope of ore dressing and to describe the various crushers used in ore dressing, To understand the theory, principle and working of various ball mills used for size reduction)

Scope and objective of ore dressing, Sampling of ores by different methods. Theory of liberation of minerals. Crushers: -Jaw, Gyratory, Cone, Rolls, and toothed roll crushers.
Types of grinding operations like batch and continuous dry and wet grinding, open circuit and closed circuit grinding. Grinding Mills: Ball mills, theory of ball mill operation, rod and tube mills. Comminution laws: - Rittinger's laws, Kick's law and Bond's law.

UNIT II

(Learning objective: To explain the theory and principles of various sizing techniques. It also describes the movement of solids in fluids by explaining the effect of various parameters on the movement of solids.)

Sizing: Study of laboratory sizing techniques and reporting of sizing data. Industrial sizing units: Types of screen surfaces. Grizzlies, trommels, vibrating and shaking screens. Movement of solids in fluids: Stokes and Newton's laws. Terminal velocity and its relation with size. Relation between time and velocity. Relation between distance travelled and velocity. Equal settling ratio, Free and hindered settling ratios. Quantifying concentrating operations: Ratio of concentration, recovery, selectivity index and economic recovery.

UNIT III

(Learning objectives: To understand the principles and working of classifiers. The student should also understand various heavy media separation methods.)

Classification of classifiers, study of settling cones, rake classifier, spiral classifier, and cyclones. Heavy media separation: Principles, flow chart, different media used. Heavy media separation using heavy liquids and heavy suspensions. Washability curves for easy, normal and difficult coal.

UNIT IV

(Learning objectives: The basic concepts involved in jigging and tabling will be detailed to understand the working of various jigging machines and other equipment involved with tabling.)

Jigging: Theory of jigging. Jigging machines: hand jig, Harz jig, Denver jig, Baum jig, Hancock jig, James coal jig, and halkyn jig. Design considerations in a jig. Tabling: -study of stratification on a table. Shaking tables, wilfley table. Humphrey's spiral classifier.

UNIT V

(Learning objectives: To understand the principles and applications of flotation and other separation processes and to be getting acquainted with the working of equipment used for floatation process.)

Flotation: Principles of flotation, Factors affecting flotation. Classification of collectors and frothers. Regulators factors affecting their efficiency. Flotation machines: -Pneumatic and mechanical flotation cells. Application of flotation process for Cu, Pb and Zn ores. Magnetic separation processes and electrostatic separation process.

(*Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)*

TEXTBOOK:

1. Principles of Mineral Dressing by A.M. Gaudin.

REFERENCES:

1. Elements of Ore Dressing by A.F. Taggart
2. Mineral processing technology-.A. Wills
3. Ore dressing practices-S.K.Jain.

II- Year I-Semester	PHYSICAL METALLURGY	L	T	P	C
		3	0	0	3

(Course Objective: It is an introductory course for the students of Metallurgical Engineering and the subject deals with the fundamental concepts about the crystal structures, phase diagrams, and their applications.)

UNIT – I

(Learning objective: To understand the basic crystal structures of various materials which forms the basis for the subsequent study of properties of materials.)

Structure of Metals, Hume-Rothery's classification of metals, metallic bond-crystal structure of metals, coordination number, relationship between lattice parameter and atomic radius, packing factor and density calculations, interstitials, polymorphism, plane and directional indices, transformation of indices.

UNIT – II

(Learning objective: To understand the constitution and necessity of alloy formation. To study the associated Hume Rothery rules for the formation of alloys.)

Constitution of Alloys: Necessity of alloying; types of solid solutions, Hume-Rothery's rules. Intermediate alloy phases, electro-chemical compounds, size factor, compounds, and electron phases.

UNIT – III

(Learning objective: The chapter outlines the various experimental methods of construction of phase diagrams. The unit also outlines the solidification behaviour of materials during cooling.)

Equilibrium Diagrams: Experimental methods for construction of equilibrium diagrams, Isomorphous alloy systems, eutectic and partial eutectic systems.
Solidification: Types of Nucleation, determination of the size of critical nucleus, equilibrium cooling and heating of alloys, lever rule, coring, miscibility gaps. Simple problems using lever rule.

UNIT – IV

(Learning objective: The unit intended to describe various phase diagrams and phase transformations)

Transformation in solid-state, allotropy, order-disorder transformation, eutectoid, peritectoid reactions and complex phase diagrams, relation between equilibrium diagrams and physical properties of alloys. Study of important binary phase diagrams like Fe-Fe_3 C, Cu-Zn, Cu-Sn, and Al-Cu.

UNIT – V

(Learning objectives: To provide the detailed explanation of phase transformations in steels and to understand the importance of isothermal diagrams)

Phase transformations in steels pearlitic, martensitic and bainitic transformations cooling curves. Isothermal transformation diagrams, transformations on continuous cooling.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities with special focus on academically weak students) should be tested periodically in classes by giving problems with respect to Phase diagrams and others. Unit tests are to be conducted at the end of each unit).

TEXTBOOK:

1. Introduction to Physical Metallurgy – S.H. Avner- McGraw-Hill publishers
2. Physical Metallurgy – Viajyendra Singh, Standard Publishers Distributors, 2005

REFERENCES:

1. Physical Metallurgy principles-Reed Hill – CENGAGE Learning Publishers
2. Engineering Physical Metallurgy and Heat Treatment – Y. Laktin.
3. Elements of Physical Metallurgy – A.Guy
4. Metallographic laboratory practice – Kehl
5. Principles of Physical Metallurgy – Smith. M.
6. Introduction to Metallurgy – A.H. Cottrell
7. Metallurgy for Engineers-Clark and Varney.
8. Physical Foundations of Materials Science – G. Gottstein
9. The Science and Engineering of Materials – Askeland et. al.
10. Physical Metallurgy – William F Hasford – CRC Press
11. Callister's Materials Science and Engineering, Adapted by R.Balasubramaniam, second edition, Wiley, 2015

II- Year I-Semester	**Vector Calculus, Transforms and PDE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

- To familiarize the techniques in partial differential equations
- To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

Unit –I: Vector calculus: (10 hrs)

Vector Differentiation: Gradient – Directional derivative – Divergence – Curl – Scalar Potential. Vector Integration: Line integral – Work done – Area – Surface and volume integrals – Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof).

Unit –II: Laplace Transforms: (10 hrs)

Laplace transforms of standard functions – Shifting theorems – Transforms of derivatives and integrals – Unit step function – Dirac's delta function – Inverse Laplace transforms – Convolution theorem (with out proof).

Applications: Solving ordinary differential equations (initial value problems) and integro differential equations using Laplace transforms.

Unit –III: Fourier series and Fourier Transforms: (10 hrs)

Fourier Series: Introduction – Periodic functions – Fourier series of periodic function – Dirichlet's conditions – Even and odd functions – Change of interval – Half-range sine and cosine series.

Fourier Transforms: Fourier integral theorem (without proof) – Fourier sine and cosine integrals – Sine and cosine transforms – Properties – inverse transforms – Finite Fourier transforms.

Unit –IV: PDE of first order: **(8 hrs)**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.

UNIT V: Second order PDE and Applications: (10 hrs)

Second order PDE: Solutions of linear partial differential equations with constant coefficients – RHS term of the type $e^{ax+by}, \sin(ax+by), \cos(ax+by), x^m y^n$.

Applications of PDE: Method of separation of Variables – Solution of One dimensional Wave, Heat and two-dimensional Laplace equation.

Course Outcomes:

At the end of the course, the student will be able to

- interpret the physical meaning of different operators such as gradient, curl and divergence
- estimate the work done against a field, circulation and flux using vector calculus
- apply the Laplace transform for solving differential equations
- find or compute the Fourier series of periodic signals
- know and be able to apply integral expressions for the forwards and inverse Fourier transform to a range of non-periodic waveforms
- identify solution methods for partial differential equations that model physical processes

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **Erwin Kreyszig,** Advanced Engineering Mathematics, 10th Edition, Wiley-India.

Reference Books:

1. **B. V. Ramana,** Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.
2. **Dean. G. Duffy,** Advanced Engineering Mathematics with MATLAB, 3rd Edition, CRC Press.
3. **Peter O' Neil,** Advanced Engineering Mathematics, Cengage.
4. **Srimantha Pal, S C Bhunia,** Engineering Mathematics, Oxford University Press.

II- Year I-Semester	**THERMODYNAMICS AND KINETICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

(Course Objective: To provide comprehensive coverage of the laws of thermodynamics, reaction Kinetics, and their applications so as to prepare the student for professional practice.)

UNIT-I

(Learning Objectives: The student can understand the basic concepts of the properties of a system to help them to get a clear understanding of reversible and irreversible processes.)

Objectives and limitations to thermodynamics, concepts of system and state, heterogeneous and homogeneous systems, extensive and intensive properties of system, thermodynamic variables, thermodynamic equilibrium. Reversible and irreversible processes.

UNIT-II

(Learning Objectives: The student can understand the clear concept of enthalpy and internal energy. It also helps in understanding the classification of work. These basic concepts will make the student to understand systems concept of manufacturing processes. It helps the student to identify, formulate and solve engineering problems.)

First and Second laws Law of thermodynamics: Nature of first law, relationship between heat and work, internal energy and the first law of thermodynamics, calculations of work, constant capacity, reversible adiabatic processes, reversible isothermal pressure or volume changes of an ideal gas, enthalpy change with temperature, Kirchhoff's equation. Second law of thermodynamics: Efficiency of a cyclic process, Carnot cycle, Carnot theorem, second law of thermodynamics, concept of entropy

UNIT-III

(Learning Objectives: To understand the concepts of free energy and entropy. To understand the relationship between these functions and their applications in various thermodynamic processes. It helps the student to identify, formulate and solve engineering problems.)

Third law of thermodynamics: Background of third law deductions from third law, applications of third law, and other methods of obtaining ΔS^0 for a reaction. Free energy functions: Purposes of the new functions, definition of Helmholtz and Gibbs free energy change, meaning of thermodynamically possible process, determination of ΔG from thermal data useful relationships between free energies and other thermodynamic functions, Maxwell's equation and Gibbs-Helmholtz equation.

UNIT-IV

(Learning Objectives: To know the concepts of activity and equilibrium constants. It helps the student to identify, formulate and solve engineering problems.)

Fugacity, activity and equilibrium constant: Concepts of fugacity, activity and equilibrium constant variation of the equilibrium constant with temperature, Calculation of equilibrium constant from free energy changes, derivation of the Clausius – Clapeyron equation for single substance, Duhriges rule for the estimation of the vapour pressures of an element, Integration of Clausius – Clapeyron equation. Problems.

UNIT –V

(Learning Objectives: To understand the kinetics of chemical processes and simultaneous reactions. It helps the student to identify, formulate and solve engineering problems.)

Kinetics: Kinetics of chemical process, Molecularity, and order of a reaction, zero-order reactions, first-order, second-order reactions, Determination of order of reaction, collision theory, theory of absolute reaction rates, consecutive and simultaneous reactions, catalysis in chemical reactions.

TEXTBOOK:

1. Introduction to the thermodynamics of materials 5th Edition– D.R. Gaskell – CRC Press
2. Principles of metallurgical thermodynamics- S. K. Bose and S.K. Roy, University Press 2014

REFERENCES:

1. Thermodynamics of solids-R.S.Swalin
2. Physical chemistry of metals-L.S.Darken & Gurry
3. Physical Metallurgy Principles – RH Reed hill.
4. Thermodynamics An Engineering Approach – Cengel – Mcgraw-Hill – 7th Edition
5. Fundamentals of thermodynamics-Sonntag et al
6. An Introduction to thermodynamics-Y.V.C.Rao
7. Chemical and Metallurgical thermodynamics – Prasad Krishnakanth – New Age Publications
8. Text Book of Materials and Metallurgical Thermodynamics: Ahindra Ghosh (PHI)

II- Year I-Semester	**METALLURGICAL ANALYSIS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

(Course objective: To study the methods of analysis of various metals and alloys quantitatively and qualitatively.)

UNIT-I:
(Learning objective: To know the importance of various methods of Metallurgical analysis.)

Importance of chemical analysis, scope of metallurgical analysis, classification of various methods used in metallurgical analysis. Solution preparations, normality, molarity, molality, Equivalent weight. Dissolution of ores in general, dissolution of metals and alloys.

Chemical Analysis - Basic Principles - theory of indicators –Conventional solution methods for qualitative analysis of ores, fluxes, slags, metals, and refractories.

UNIT-II:
(Learning objective: To know the various methods of qualitative analysis of a few ferrous and non-ferrous metals and alloys)

Qualitative analysis of common non-ferrous alloys such as brasses, bronzes, and solders. Estimation of C, S, Si, Mn, and P in cast iron and steel.

UNIT-III:
(Learning objective: To estimate various elements present in various ores)

Estimation of Cr, Ni, Mo, W, and V in alloy steels. Determination of iron in iron ore, manganese in manganese ores, lime in limestone, fire-assay of precious metals.

UNIT-IV:
(Learning objective: To describe various instrumental methods of analysis and to compare the results with different wet methods)

Instrumental analysis: Importance of instrumental analysis –Comparison with standard wet chemical methods - Fundamental Physicochemical principles involved and equipment required in absorptiometry i.e., colorimetry and spectrophotometry, colorimetric titration.

UNIT-V:
(Learning objective: To describe various advanced instrumental methods of analysis)

Spectroscopy, potentiometry, amperometric titration. Calorimetric titrations, polarography, conductometry, electro-analysis, and flame photometry.

(Assessment: The student should be evaluated based on the assignments and objective tests. Emphasis should be given by conducting tutorial classes (with a special focus on academically weak students) at the end of each unit).

TEXTBOOK:

1. S.K.Jain-Metallurgical analysis.

REFERENCES:

1. Iyer V.G., Metallurgical Analysis: BHU Press, Varanasi.
2. Agarwal, B.C. and Jain S.P., A Text Book of Metallurgical Analysis, Khanna Publishers, Delhi -1963.
3. Snell Foster D and Frank M Biffen: Commercial methods.of analysis / Che. Publishing Co.,1964
4. Vogel Al., A Text Book of Quantitative Inorganic Analysis Longman ELBS 1962.
5. Willard H.H.etal: Instrumental Methods of analysis Van Nostrand.

II- Year I-Semester	**METALLURGICAL ANALYSIS LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

(*Learning objective: Design the sequence of operations in a logical order. The relevant tabular forms are to be prepared. Experiments are to be conducted taking the necessary precautions. The data should be recorded and the results need to be interpreted using the necessary mathematical expressions. The graphs are to be drawn where ever required and the appropriate conclusions should be presented.)*

1. Estimation of Iron in Iron ore. - To determine the percentage of Iron in Iron Ore by KMnO4 method and K**2**Cr**2**O**7** method.
2. Estimation of Silicon in Cast Iron.
3. Estimation of Carbon in Steel by Strohlein apparatus method.
4. Estimation of Copper in Brass by Electrolytic method.
5. Estimation of manganese in cast iron.
6. Estimation of Chromium in Steel.
7. Estimation of Sodium and Potassium in Chloride Salts by Flame Photometry.
8. Estimation of lime in Limestone.
9. Estimation of the concentration of KMnO**4** in the solution using Digital Spectrophotometer.
10. Estimation of Sulphur and Phosphorus in cast irons.
11. Estimation of Chromium in Stainless steels.
12. Estimation of Mn, Cr, and Si in Ferro-Alloys

EQUIPMENT:

1. Optical emission spectrometer
2. Flame Photometer
3. Digital Spectrophotometer
4. Electronic digital balances – 2 No's

(Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:

I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

II.

1. *At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)*

II- Year I-Semester	**MINERAL PROCESSING LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

(Learning objective: Design the sequence of operations in a logical order. The relevant tabular forms are to be prepared. Experiments are to be conducted taking the necessary precautions. The data should be recorded and the results need to be interpreted using the necessary mathematical expressions. The graphs are to be drawn where ever required and the appropriate conclusions should be presented.)

List of Experiments

1. Sampling of ore from the bulk by:
   Coning and quartering method, Riffle sampler methods
2. Sizing by Sieve analysis of crushed ore
3. Verification of Stoke's Law.
4. Determining the reduction ratio of a jaw crusher.
5. Study of the variation of reduction ratio with process variables in Rolls crusher.
6. Study of the process variables on reduction ratio and particle size distribution in ball mill.
7. To find the grindability index of ores.
8. Verification of Laws of Comminution.
9. Determination of the efficiency of a magnetic separator.
10. Determination of the efficiency of a jig.
11. Study of the particle separation by fluid flow using wilfley table.
12. Determination of the efficiency of a pneumatic separator.
13. To study the concentration of metallic and non-metallic ores by Froth-Flotation process.

Equipment:

1. Riffle Sampler
2. Sieve Shakar with Sieves
3. Stokes' Apparatus
4. Jaw Crusher
5. Roll Crusher
6. Ball Mill
7. Grindability Index Apparatus
8. Magnetic Separator
9. Jig
10. Wilfly's Table
11. Pneumatic Separator
12. Froth – Floatation Equipment
13. Balances

II- Year I-Semester	**PHYSICAL METALLURGY LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

(Learning objective: Design the sequence of operations in a logical order. Experiments are to be conducted taking the necessary precautions. The microstructures should be observed at various magnifications and the structure should be interpreted and conclusions should be presented.)

LIST OF EXPERIMENTS

1. Preparation and study of Crystal models.
2. Study of: Specimen cutting machine Specimen mounting press Grinding and polishing equipment
3. Study of various Metallurgical Microscopes and use of levelling press
4. Metallographic preparation of ferrous specimens for Microscopic examination
5. Preparation of non-ferrous specimens for Metallographic examination
6. Preparation and Metallographic study of pure metals like Iron, Copper, Aluminium, etc..
7. Measurement of lattice parameters of various crystal structures and calculation of packing factors and size of vacancies.
8. Identification of Microstructures of steels

Equipment:

1. Specimen Cutting Machine
2. Specimen Mounting Press
3. Belt Grinding Machine
4. Disc Polishing Machines
5. Metallurgical Microscopes
6. Specimen Leveller.
7. Image analyser
8. Standard samples with their microstructures

II- Year II-Semester	IRON MAKING	L	T	P	C
		3	0	0	3

***(Course objective:** The subject deals with preparation of various types of iron ores, agglomeration methods and operation of Blast Furnace)*

UNIT-I

(Learning Objectives: To know the availability and preparation of iron ores. To understand various agglomeration techniques of iron ores and their importance)

Occurrence and distribution of iron ores in India and in the world, Preparation of iron ores.
Sintering: Principles, raw materials, and DL. machine. Mechanism of sintering. sintering bonds. Factors affecting sintering efficiency. Pelletisation: Theory of pellatisation, Water-particles system. Production of green pellets: disk and drum pelletisers, Induration of pellets: Shaft, traveling grate.

UNIT-II
*(Learning Objectives**:** Study of BF coke, BF gases, and their cleaning*.)

Blast furnace coke: Functions, properties and uses, BF profile and design considerations. Furnace lining. Furnace cooling system. Hoisting equipment. B.F. Stoves. BF gas cleaning system and gas use.

UNIT-III
(Learning Objectives: Study of Physical Chemistry of reduction of ores, and uses and properties of slags.)

Physical chemistry of reduction of iron ores: Physical and chemical factors affecting the reduction of ores. Relevant CO/CO2 and H2/H2O diagram. Controls of C, Si, S, P in metals and slags.

Blast furnace slags: Its constitution. Effect of CaO, SiO2, Al2O3, and MgO on fluidity of slags. Uses of slags.

UNIT-IV
(Learning Objective: To understand the design and operation of Blast Furnace, blast furnace irregularities and methods of increasing productivity)

Blast Furnace Operation: Blowing in, blowing out, fanning and draughting. BF irregularities and their control/remedies. Development of BF: HTP, humidification of blast. O2 enrichment, hot blast temperature, BF additives, and top charging systems.

UNIT-V

(Learning Objective: BF Burden calculations and study of alternate routes of iron making including wrought iron.)

BF Burden calculations: Raceways parameters. Factors affecting it. Alternative routes of iron making: Electric pig iron smelting, low shaft and small shaft B.F. Classification of sponge iron making. HYL, Kiln Krupp-Renn, Midrex process. Production of wrought iron.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

TEXTBOOK

Modern Iron making Dr. R.H. Tupkary

REFERENCE BOOKS

1. Blast furnace theory and practice Vol. 1 and 2 edited by Julius H. Strass burger.
2. Principles of blast furnace Iron Making A.K. Biswas.

II- Year II-Semester	**Elements of Mechanical Engineering**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

(Objectives: The course conveys the basic concepts of Mechanical Engineering and exposes the students to a wide range of hardware and the hands-on nature of engineering. The subject provides a base for the students to understand various concepts relevant to boilers, compressors, IC engines, gear transmission etc..)

UNIT – I

(Learning Objectives: To understand the concepts of air standard cycles used in prime movers. To identify, formulate and solve engineering problems associated with various cycles used in prime movers of CI engines.)

Actual Cycles and their Analysis: Introduction, Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blowdown-Loss due to Gas exchange process, Volumetric Efficiency. Loss due to Rubbing Friction, Actual and Fuel-Air Cycles Of CI Engines.

Unit-II

(Learning Objectives: To understand the concept of steam generation for prime movers, also to design and conduct experiments, analyze and interpret data of various types of steam boilers.)

Steam boilers: Classification of boilers, essentialities of boilers, selection of boilers, study of boilers, Cochran boiler, Locomotive boiler, Lancashire boiler, Babcock and Wilcox boiler, boiler mountings and accessories.

Unit-III

(Learning Objectives: To know the contemporary issues with various types of compressors and IC engines used in various metallurgical industries. To identify, formulate and solve engineering problems involved with compressor systems and IC engines)

COMPRESSORS – Classification –positive displacement and roto dynamic machinery – Power producing and power absorbing machines, fan, blower and compressor – positive displacement and dynamic types – reciprocating and rotary types.

Reciprocating Compressors: Principle of operation, work required, Isothermal efficiency volumetric efficiency and effect of clearance, 2-stage compression, intercooling, saving of work, minimum work condition for 2-stage compression.

Internal combustion engines: classification of IC engines, basic engine components and nomenclature, working principle of engines, Four strokes and two stroke petrol and diesel engines, comparison of CI and SI engines, comparison of four stroke and two stroke engines, simple problems such as indicated power, brake power, friction power, specific fuel consumption, brake thermal efficiency, indicated thermal efficiency and mechanical efficiency.

Unit-IV

(Learning Objectives: To design a transmission system to meet the desired needs and the existing constraints. Also to identify, formulate and solve engineering problems concerned with various drive systems.)

Belts –Ropes and chains: belt and rope drives, velocity ratio, slip, length of belt , open belt and cross belt drives, ratio of friction tensions, centrifugal tension in a belt, power transmitted by belts and ropes, initial tensions in the belt, Maximum tension - simple problems – chains: Length, angular speed ratio, Classification of chains.

Unit-V

(Learning Objectives: To apply knowledge of maths, science and engineering to derive various formulae associated with gear transmissions widely used in industries. Also to understand safety, manufacturability and sustainability constraints involved with the systems.)

Gear trains: Classification of gears, gear trains velocity ratio, simple, compound –reverted and epicyclic gear trains. Higher gear pairs – Friction wheels and toothed gears – Types – Law of gearing – Simple problems.

(Assessment: The student should be evaluated based on the assignments and objective tests. Emphasis should be given by conducting tutorial classes (With a focus on academically weak students) at the end of each unit.

Text Books

7. An introduction to Mechanical Engineering – second edition – Jonadhan Wickert., CENGAGE publishers
8. Elements of Mechanical Engineering – A. S. Ravindra – Cengage Publishers – 8th Edition

Reference books:

1. Thermal Engineering, Ballaney,P.L., Khanna Publishers, 2003
2. Theory of Machines, S.S. Rattan , Tata McGraw Hill
3. Basic Mechanical Engineering – A R Israni and P K Shah – B S Publications.

II- Year II-Semester	**Complex Variables and Statistical Methods**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

(Common to ECE, EEE of II B.Tech-I Semester & Civil, ME, MET)

Course Objectives:

- To familiarize the complex variables.
- To familiarize the students with the foundations of probability and statistical methods.
- To equip the students to solve application problems in their disciplines.
-

UNIT-I: Functions of a complex variable and Complex integration: (10 hrs)

Introduction – Continuity – Differentiability – Analyticity – Properties –Cauchy-Riemann equations in Cartesian and polar coordinates – Harmonicand conjugate harmonic functions – Milne – Thompson method.

Complex integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula – Generalized integral formula (all without proofs).

UNIT-II:Series expansions and Residue Theorem: (10 hrs)

Radius of convergence – Expansion in Taylor's series, Maclaurin's series andLaurent series.Types of Singularities: Isolated – pole of order m –Essential – Residues – Residue theorem (without proof) – Evaluation of real integral of the type $\int_{-\infty}^{\infty} f(x)dx$

UNIT – III: Probability and Distributions: (10 hrs)

Review of probability and Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution function – Mathematical Expectation and Variance – Binomial, Poisson, Uniform and Normal distributions.

UNIT – IV: Sampling Theory: (8 hrs)

Introduction – Population and samples – Sampling distribution of Means and Variance (definition only) – Central limit theorem (without proof) – Introduction to t, χ^2 and F-distributions – Point and Interval estimations – Maximum error of estimate.

UNIT – V: Tests of Hypothesis: (10 hrs)

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors – Level of significance – One tail and two-tail tests – Tests concerning one mean and two means (Large and Small samples) – Tests on proportions.

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

- apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic
- find the differentiation and integration of complex functions used in engineering problems
- make use of the Cauchy residue theorem to evaluate certain integrals
- apply discrete and continuous probability distributions
- design the components of a classical hypothesis test
- infer the statistical inferential methods based on small and large sampling tests

Text Books:

1. **B. S. Grewal,** Higher Engineering Mathematics, 43rd Edition, Khanna Publishers.
2. **Miller and Freund's,** Probability and Statistics for Engineers,7/e, Pearson, 2008.

Reference Books:

1. **S.C. Gupta and V.K. Kapoor**, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.
2. **Jay l. Devore,** Probability and Statistics for Engineering and the Sciences, 8th Edition,Cengage.
3. **Shron L.Myers, Keying Ye, Ronald E Walpole,** Probability and Statistics Engineers and the Scientists,8th Edition, Pearson 2007.
4. **Sheldon, M. Ross**, Introduction to probability and statistics Engineers and the Scientists, 4thEdition, Academic Foundation,2011.

II- Year II-Semester	PHASE TRANSFORMATIONS AND HEAT-TREATMENT	L	T	P	C
		3	0	0	3

***(Course Objective:** This subject deals with Principles of heat treatment of steels, Alloy steels, and some non-ferrous alloys and different heat treatment methods.)*

UNIT-I

(Learning Objective: This unit deals with principles of heat treatment, and different hardenability methods.)

Principles Of Heat Treatment: Austenitic Transformation, Pearlitic Transformation, Bainitic Transformation, Martensitic Transformation, Annealing, Normalizing, Hardening, mechanism of heat removal during quenching, quenching media, size and mass effect, hardenability, tempering, austempering, manufacturing, deep freezing. Heat treatment furnaces and their design, atmosphere control vacuum heat treatment, etc.

UNIT-II

(Learning Objective: To learn about different surface hardening methods.)

Surface heat treatment, carburizing, cyaniding, flame and induction hardening, residual stresses, deep freezing, thermomechanical treatments: HTMT, LTMT, Ausforming, Isoforming, Cryoforming.

UNIT-III

(Learning Objective: This topic throws light on TTT Curves and the effect of alloying elements on Fe-Fe_3C system.)

Effect Of Alloy Elements: Purpose of alloying, effect of alloying elements on ferrite, cementite, Fe- Fe_3C system, tempering, and TTT Curves.

UNIT-IV

(Learning Objective: This topic explains heat treatment of various types of tool, die steels and cast irons.)

Alloy Steels: Structural and constructional steels, maraging steels, tool and die steels. Corrosion and heat resistant steels, Hadfield steels, magnetic steels and alloys, free machining steels.

Cast Irons: White cast iron, grey cast iron, spheroidal graphite iron, malleable cast iron, alloy cast iron.

UNIT-V

(Learning Objective: To understand the principles of heat treatment of various non-ferrous alloys.)

Non-Ferrous Metals And Alloys: Precipitation hardening, aging treatment, the study of copper and its alloys, aluminium and its alloys, nickel and its alloys.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with grinding focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

TEXTBOOK

1. Heat Treatment Principle and Techniques-Rajan & Sharma
2. Heat treatment of metals- Vijayendra Singh, 2nd edition, Standard Publishers Distributors, 2006

REFERENCES

1. Heat Treatment of metals-Zakharv-Mir Publishers
2. Physical Metallurgy Lakhtin-Mir Publishers
3. Physical Metallurgy - Clark and Varney
4. Physical Metallurgy Principles - Reed Hill
5. Physical metallurgy-Raghavan
6. Materials Science and Engineering, Adapted by R.Balasubramaniam, second edition, Wiley, 2015

II- Year II-Semester	**FUELS, FURNACES AAND REFRACTORIES (PE-I)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

(Course objective: *The subject deals with various types of fuels, their origin, classification, and their properties. It also deals with various types of furnaces, their working principle, the types of Refractories used in them and various types of temperature measuring instruments.)*

UNIT I

(Learning Objectives: To study the origin, classification, and analysis of industrial fuels. Manufacture and testing of metallurgical coke along with the properties are to be studied))

Introduction to Fuels technology Classification of fuels Origin and classification of coal Analysis of Coal Proximate and ultimate analysis.

Pulverized fuels Principle of Carbonization Manufacture of Metallurgical coke Properties of Metallurgical Coke Testing of Coke.

UNIT II

(Learning Objectives: Study of fuel oil production and fuel gases production and their uses)

Principles of production of fuel oils from crude. Manufacture, properties and uses of
a) Producer gas
b) Water-gas Properties and uses of Blast furnace gas and coke oven gas; cleaning of Blast furnace gas.

UNIT III

(Learning Objectives: Study of heat transfer through various bodies. Solving problems pertaining to them. Study of different furnaces.)

Steady-State Heat Transfer: Importance of Heat transfer, conduction through a plane, cylindrical, Spherical and compound walls, shape factor and effect of variable thermal conductivity
Furnaces: Characteristic features of vertical shaft furnaces, reverberatory furnaces, Arc and Induction furnaces. Tube and muffle type resistance furnaces, continuous furnaces. Sources of heat losses in furnaces and heat balance.

UNIT-IV

(Learning Objectives: To study various types of pyrometers used in the industry.)

Pyrometry: Thermoelectric pyrometry- Peltier and Thomas e.m.f's. Thermo-electric power of thermocouples. Required properties of thermocouples. Noble and base metal thermocouples. Thermo-pile. Measurement of e.m.f by Milli-voltmeters and potentiometers. Thermometer; optical and radiation pyrometer.

UNIT V

(Learning Objectives: To study different types of Refractories, their manufacturer, properties and industrial users.)

Refractories: Desirable properties of Refractories. Methods of classification. Modes of failure of refractories in service and their prevention. Manufacturing methods and properties of Fireclay, Silica Magnesite and Chrome-Refractories. Testing of Refractories. Applications of refractories in the metallurgical industries.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

TEXTBOOK:

1. Furnaces, Fuels, and Refractories by O.P. Gupta, Khanna Publishers.

REFERENCE BOOKS:

1. Elements of fuel technology -HIMUS
2. Refractories Norton
3. Refractories-R.Chisti.
4. Furances-J.D.Gilchrist
5. Pyrometry-W.P.wood& J.M.corck
6. Fuels Furnaces, Refractories& Pyrometry-A.V.K.Surya Narayana.
7. Elements of heat transfer- Jakob&Hawikns.
8. Elements of thermodynamics& heat transfer- Obert & Young.
9. Control systems & Instrumentation S.Bhasker.

II- Year II-Semester	**LIGHT METAL TECHNOLOGY (PE-I)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

(Course Objective: To study the importance, properties, and applications of various wrought and cast light metals and their alloys)

UNIT-I
(Learning Objective: To learn the extraction process, properties, and applications of Al and its alloys.)

Aluminium and its alloys: Extraction – Properties – Applications. Wrought and Casting Alloys (Al-Cu, Al-Mn, Al-Si, Al-Mg, Al-Si-Mg, Al-Zn, Al-Li) – Corrosion resistance of Al alloys.

UNIT – II
(Learning Objective: To learn the properties and applications of Be and its alloys. Ti and its alloys)

Properties of light metals – properties and applications of Beryllium
Properties and applications of titanium and its alloys.

UNIT-III
(Learning Objective: To learn the properties and applications of Mg and its alloys)

Magnesium – Classification – Casting alloys – Wrought alloys-properties and applications of Mg alloys.

UNIT-IV
(Learning Objective: To learn the properties and applications of Zn and its alloys)

Properties and applications of Zn and its alloys

UNIT-V
(Learning Objective: To learn the properties and applications of Zr and its alloys)

Extraction, Properties, and applications of Zr and its alloys

(Assessment: The student should be evaluated based on the assignments and objective tests. Emphasis should be given by conducting tutorial classes (With a focus on academically weak students) at the end of each unit.)

TEXTBOOK

1. Light alloys: Metallurgy of light metals, I. J. Polmear, 2nd edition, Edward Arnold Publishers, 1989

REFERENCES

1. Light alloys: from traditional alloys to nanocrystals, I. J. Polmear and David St. John, BH-Elsevier, 4th edition 2006
2. ASM Metals Handbook Vol-1 & 2

II- Year II-Semester	**COMPUTATIONAL MATERIALS ENGINEERING (PE-I)**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

(Course objective: *The subject deals with various types of fuels, their origin, classification, and their properties. It also deals with various types of furnaces, their working principle, the types of Refractories used in them and various types of temperature measuring instruments.)*

UNIT I

(Learning Objectives: To study the origin, classification, and analysis of industrial fuels. Manufacture and testing of metallurgical coke along with the properties are to be studied))

Introduction to Fuels technology Classification of fuels Origin and classification of coal Analysis of Coal Proximate and ultimate analysis.

Pulverized fuels Principle of Carbonization Manufacture of Metallurgical coke Properties of Metallurgical Coke Testing of Coke.

UNIT II

(Learning Objectives: Study of fuel oil production and fuel gases production and their uses)

Principles of production of fuel oils from crude. Manufacture, properties and uses of
a) Producer gas
b) Water-gas Properties and uses of Blast furnace gas and coke oven gas; cleaning of Blast furnace gas.

UNIT III

(Learning Objectives: Study of heat transfer through various bodies. Solving problems pertaining to them. Study of different furnaces.)

Steady-State Heat Transfer: Importance of Heat transfer, conduction through a plane, cylindrical, Spherical and compound walls, shape factor and effect of variable thermal conductivity
Furnaces: Characteristic features of vertical shaft furnaces, reverberatory furnaces, Arc and Induction furnaces. Tube and muffle type resistance furnaces, continuous furnaces. Sources of heat losses in furnaces and heat balance.

UNIT-IV

(Learning Objectives: To study various types of pyrometers used in the industry.)

Pyrometry: Thermoelectric pyrometry- Peltier and Thomas e.m.f's. Thermo-electric power of thermocouples. Required properties of thermocouples. Noble and base metal thermocouples. Thermo-pile. Measurement of e.m.f by Milli-voltmeters and potentiometers. Thermometer; optical and radiation pyrometer.

UNIT V

(Learning Objectives: To study different types of Refractories, their manufacturer, properties and industrial users.)

Refractories: Desirable properties of Refractories. Methods of classification. Modes of failure of refractories in service and their prevention. Manufacturing methods and properties of Fireclay, Silica Magnesite and Chrome-Refractories. Testing of Refractories. Applications of refractories in the metallurgical industries.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

TEXTBOOK:

1. Furnaces, Fuels, and Refractories by O.P. Gupta, Khanna Publishers.

REFERENCE BOOKS:

1. Elements of fuel technology -HIMUS
2. Refractories Norton
3. Refractories-R.Chisti.
4. Furances-J.D.Gilchrist
5. Pyrometry-W.P.wood& J.M.corck
6. Fuels Furnaces, Refractories& Pyrometry-A.V.K.Surya Narayana.
7. Elements of heat transfer- Jakob&Hawikns.
8. Elements of thermodynamics& heat transfer- Obert & Young.
9. Control systems & Instrumentation S.Bhasker.

II- Year II-Semester	**FOUNDRY TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

(Course objective: The course deals with various types of Foundries, patterns, moulding materials and different types of casting methods including modern methods.)

UNIT I

(Learning Objectives: To know about various types of foundries and know the patterns and moulding sands and additives used for getting good moulds.)

Scope and development of Foundry. Types of foundries. PATTERNS: Materials for patterns, types of patterns; functions and pattern allowance. MOULDING MATERIALS: Moulding sands, properties and selection of materials and additives used.

UNIT II

(Learning Objectives: To know in detail about various casting processes and properties in moulds. Gating and risering in moulds.)

CASTING PROCESSES AND EQUIPMENT: Green and dry sand moulding; shell moulding, CO2 moulding. Core moulds and cores. Plaster mould casting, composite mould casting, Investment casting.
GATING AND RISERING: Gate nomenclature, gate types and types of risers.

UNIT III
(Learning Objectives: Study of different moulding processes and their equipment)

Permanent mould casting, pressure die-casting, Gravity die-casting and centrifugal casting, Types of moulding equipment.

UNIT IV
(Learning Objectives: Solidification of metals and alloys and melting practices to be studied)

SOLIDIFICATION OF METALS: Nucleation crystal growth. Freezing of metals and alloys. Dendritic freezing. Coring and segregation, ingot defects, Flow of metals in moulds.
MELTING OF FERROUS ALLOYS: ‘Melting of Gray iron and cupola. Cupola operation and control. Effect on chemical composition, carbon equivalent, and effect of alloying elements on foundry characteristics. Melting of non-ferrous alloys: Melting of Aluminium and copper alloys production processes: Production of Gray Iron, ductile iron. Malleable iron castings

UNIT V
(Learning Objectives: Various casting defects and their prevention to be studied)

Continuous casting and casting defects: Casting defects arising due to moulding, coring melting, and poring practice.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

TEXTBOOKS

1. Principles of Metal casting by Heine, Loper, and Rosenthal.
2. Foundry Technology – Dhuvendra Kumar & S.K.Jain

REFERENCE BOOKS

1. Metals Handbook Vol. 5 published by ASM, Ohio.
2. Foundry Technology-Jain
3. Foundry Technology Principles-T.V.Ramana Rao

II- Year II-Semester	**PHASE TRANSFORMATIONS AND HEAT-TREATMENT LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

(Learning objective: Design the sequence of operations in a logical order. The relevant tabular forms are to be prepared. Experiments are to be conducted taking the necessary precautions. The data should be recorded and the results need to be interpreted using the necessary mathematical expressions. The graphs are to be drawn where ever required and the appropriate conclusions should be presented.)

List of Experiments:

1. Annealing of medium carbon steel and observation of microstructure.
2. Normalizing of medium carbon steel and observation of microstructure.
3. Hardening of medium carbon steel and observation of microstructure.
4. Study of tempering characteristics of water quenched steel.
5. Study of age hardening phenomena in duralumin.
6. Spheroidizing of given high carbon steel.
7. Determination of hardenability of medium carbon steel by Jominy end Quench Test.
8. To conduct Re-crystallization studies on cold-worked copper.

Equipment:

1. Muffle Furnaces 1000^0c – 2 No's
2. Muffle Furnaces 300^0c – 2 No's
3. Muffle Furnaces 120^0c – 1 No's
4. Hardenability Apparatus
5. Micro Scopes
6. Vickers Hardness Tester

(Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:

I.

1. observation book,
2. Record.
3. Conduct of the experiment successfully
4. Interpretation of the data
5. Drawing the graphs where ever necessary
6. Viva-voce.

II.

1. *At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)*

II- Year II-Semester	**FOUNDRY TECHNOLOGY LAB**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

(Learning objective: Design the sequence of operations in a logical order. The relevant tabular forms are to be prepared. Experiments are to be conducted taking the necessary precautions. The data should be recorded and the results need to be interpreted using the necessary mathematical expressions. The graphs are to be drawn where ever required and the appropriate conclusions should be presented.)

LIST OF EXPERIMENTS:

1. Preparation of gating system using green sand.
2. Study of the particle size distribution of the sand.
3. Study of the variation of permeability of the green sand with clay and water.
4. Determination of the variation of sand properties like green hardness, green compact strength with additives in sands.
5. Determination of the variation of hot compact hardness and hot shear strength with additives in sands.
6. Determination of clay content in sand.
7. Determination of the shatter index of green sand.
8. Founding of Al and Cu alloys in a pit furnace and casting into light components.
9. Study Charge calculations and melting practice of cast iron in a cupola.
10. Preparation of a shell-by-shell moulding process.
11. Non-destructive testing of a few cast-iron components.

Equipment:

1. Mould Boxes, Patterns, Cove Boxes, Tool Boxes.
2. Rotap Sieve Shaker with Sieves
3. Permeability Apparatus.
4. Universal Sand Testing Machine with Accessories.
5. Sand Hardness tester.
6. Clay Content Apparatus
7. Shatter Index test.
8. For Melting: Pit Furnace, Electric Furnace
9. Shell Moulding Machine
10. Centrifugal Casting Machine
11. Ultra Sonic Tester
12. Ladles, Crucibles and other Accessories
13. Muffle Furnace 1000^0c

(Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:

I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

II.

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

III Year I Semester	MECHANICAL BEHAVIOR OF MATERIALS	L	P	C
		3	0	3

(Course objective: To know the fundamental concepts of mechanical behavior of materials, various mechanical testing practices and to apply them to design the materials for various load-bearing structural engineering applications.)

UNIT –I

(*Learning objectives****:*** *To know the effect of transformation of axes. To understand the concept of stress, strain, principal stress, stress tensors and elastic anisotropy)*

Concepts of stress and strain: Definition of stress and strain; transformation of axes, tensor notations; relationship between stress and strain; concepts of principal stress and principal strain; concepts of modulus; Hooke's law and understanding stiffness and compliance tensors; Elastic anisotropy.

UNIT –II

(*Learning objectives****:*** *To know the importance of yield criteria and the concept of Mohr's circle)*

Yielding: Yield criterion; equivalent stress and plastic strain, theoretical shear of perfect crystal; Moh's circle, concept of dislocations and dislocation theory; dislocation interaction; kink and jog; sessile and glissiles, partial dislocations, Thomson tetrahedral.

UNIT –III

*(Learning objectives****:*** *To understand the concept of Strengthening mechanism and various methods of Strengthening mechanisms)*

Strengthening mechanisms: Work hardening; solid solution strengthening; grain boundary strengthening; ageing; particle hardening; types of reinforcements.

UNIT –IV

(*Learning objectives: To understand the principle of hardness measurement and types of hardness measurements)*

Hardness: Types of hardness measurements; comparison among hardness methods and scales; micro-hardness; nano-indentation.

UNIT –V

*(Learning Objective****:*** *To know the fundamentals, failure and the factors affecting fatigue and creep.)*

Fracture, Fatigue and creep: Introduction to Fracture Mechanics, S-N curves; life data presentation; influence of stress; linear elastic fracture mechanics in fatigue, crack growth studies, Paris law, metallurgical aspects of fatigue failure; concepts of remedial methods; stress rupture and creep studies; deformation mechanism maps; super-plasticity; fatigue-creep interaction.

(Assessment: The student should be evaluated based on the assignments and objective tests. both formative and summative assessment procedures are to be adopted.Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Dieter G.E., Mechanical Metallurgy, McGraw Hill, 1988
2. Thomas H. Courtney, Mechanical Behavior of Materials, 2nd Edition, Overseas Press India Private Limited

Reference Books:

1. Suryanarayana, Testing of Metallic Materials; Prentice Hall India
2. Dowling N.E., Mechanical Behavior of Materials, International Edition, contributed by K.Sivaprasad and R.Narayanasamy, 2013, Pearson Education Limited.

III Year I Semester	STEEL MAKING	L	P	C
		3	0	3

(**Course objective:**To know the importance of the steel making and to apply them for the advancement of the production feasibilities in steel Industries to compete with the modern-day manufacturing routes.)

UNIT-I

*(Learning objective**:** To understand about various types of raw materials used for steel making and about various early steel making processes*.)

Classification of Steel making Processes. Early steel making processes: Cementation and crucible processes. Raw materials for steel making. Factors affecting efficiency of steel making.

UNIT-II

*(Learning objective**:** It throws some light on principles of Decarburization, Dephosphorisation and deoxidation.)*

Principles of Steel making, Decarburisation, desiliconization.Dephosphorisation and desulphurisation. Principles of deoxidation. Types of deoxidation: Precipitation, diffusion and treatment with synthetic slags, molecular and ionic theory of slags.

UNIT-III

***(**Learning objective**:** To understand steel making process by Bessemer convertor and by modern methods.)*

Construction and process details in acid and basic Bessemer convertors and openhearthfurnace.Improvement and modification of the above process.Construction and process details in LD, LD-AC, Kaldo and rotor steel making processes.Bottom blown O2 processes.

UNIT-IV

***(**Learning objective**:** To understand the principles of Solidification of steels and various Ingot defects.)*

Continuous steel making process: - Construction details of electric arc furnace; production of steel. Induction furnace for steel making, Casting pit side practice, Teeming Practices: - Direct, bottom and uphill Teeming methods.

UNIT-V

*(Learning objective**:** To understand about Continuous casting of steels.)*

Solidification of steels.Ingot defects and remedies; secondary steel making processes.Vacuum treatment of steels, Continuous casting of steels.Electro slag refining process. Vacuum arc remelting process.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by assessing group work. Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Modern Steelmaking, Dr. R.H. Tupkary and V.H. Tupkary
2. A first course in iron and steel making by Deepak Majundar

Reference Books:

1. Steel making by Kudrin V A
2. Making Shaping and Treating of Steels by United States Steel Corporation, Pittsburgh.
3. Open Hearth furnace practice - Bornatsky,
4. Manufacture of Iron and Steel, Vol. II by Gr Bashforth
5. Steel Making: A. K. Chakrabarthi (PHI)

III Year I Semester	CORROSION ENGINEERING	L	P	C
		3	0	3

(Course objective: To acquire knowledge on principles, various forms, testing, monitoring and prevention of corrosion phenomenon.)

UNIT – I
(*Learning objective****:*** *To learn about electrochemical principles*)

Electrochemical and thermodynamic principles, Nernst equation and electrode potentials of metals, EMF and galvanic series, merits and demerits; origin of Pourbaix diagram and its importance to iron, aluminium and magnesium metals

UNIT – II
*(Learning objective****:*** *To learn about the Polarization and electrochemical behavior of metals)*

Exchange current density, polarization- concentration, activation and resistance, Tafel equation; passivity, electrochemical behaviour of active/passive metals, theories of passivity

UNIT – III
*(Learning objective****:*** *To learn the principles and various types of corrsion.)*

Atmospheric, pitting, dealloying, stress corrosion cracking, intergranular corrosion, corrosion fatigue, erosion-corrosion, fretting corrosion and high temperature oxidation; hot corrosion; causes and remedial measures

UNIT – IV
*(Learning objective****:*** *To learn about various corrosion testing procedures and sequential procedure for laboratory and on-site corrosion investigations)*

Purpose of testing, laboratory, semi-plant and field tests, susceptibility tests for IGC, stress corrosion cracking and pitting, immersion and salt spray testing, impedance analysis, sequential procedure for laboratory and on-site corrosion investigations, corrosion auditing and corrosion map of India

UNIT – V
*(Learning objective****:*** *To understand various protective methods of corrosion.)*

Corrosion prevention by design improvements, anodic and cathodic protection, metallic, non-metallic and inorganic coatings, mechanical and chemical methods and various corrosion inhibitors

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities should by conducting concept tests. Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Fontana M. G., Greene N.D., 'CorrosionEngineering',2nd Edition, McGrawHill,1983

Reference Books:

1. Raj Narayan, 'An Introduction to Metallic Corrosion and itsPrevention',1stEdition, Oxford and IBH, 1983
2. Denny Jones, "Principles and Prevention of Corrosion", Prentice Hall of India,1996.

III Year I Semester	NON FERROUS EXTRACTIVE METALLURGY	L	P	C
		3	0	3

(Course objective: To explain the various methods of extraction of nonferrous metals and to describe the procedure and equipment used for production of nonferrous metals from their ores)**.**

UNIT – I
*(Learning Objective**:** Study of Extraction of copper from minerals to electro winning*.)

COPPER: Principal Ore and Minerals; Matte smelting – Blast furnace, Reverberatory furnace, Electricfurnace, Flash; Converting; Continuous production of blister Copper; Fire refining; Electrolytic refining; Hydro-Metallurgical copper extraction; Leaching processes, Recovery of copper from leach solutions; Electro-winning.

UNIT – II
*(Learning Objective**:** Study of Extraction of lead and Zinc*.)

ZINC: General Principles: Horizontal and vertical retort processes: Production in a Blast furnace:Leaching purification: Electrolysis, Refining.

LEAD: Blast furnace smelting, Refining of lead bullion

UNIT – III
*(Learning Objective**:** Study of Extraction of Aluminium by different processes)*

ALUMINIUM: Bayer process, Hall - Heroult process, Anode effect: Efficiency of the process, Refining, Alternative processes of aluminium production.

UNIT – IV
*(Learning Objective**:** Extraction of light metals like magnesium and titanium from various sources and methods)*

MAGNESIUM: Production of a hydrous Magnesium chloride from sea water and magnesite. Electro-winning practice and problem, refining, Pidgeon and Hansgrig processes.

TITANIUM: Upgrading of ilmenite, chlorination of titania, Kroll's process. Refining.

UNIT – V
*(Learning Objective**:** Purification of Uranium ore and production of reactor grade UO2 and U and study of simplified flow sheets of various metals and review of NF Industry in India.)*

URANIUM: Acid and alkali processes for digestion of uranium ores, Purification of crude salt, Production of reactor grade UO2 and uranium.

Simplified flow sheets for the extraction of nickel, tungsten and gold. Review of non-ferrous metal industries in India.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems.)

Text Books:

1. Extraction of Non-Ferrous Metals - HS Ray, KP Abraham and R. Sridhar
2. Metallurgy of Non-Ferrous Metals - WH Dennis

Reference Books:

1. Rare Metals Hand book - C.A. Hampel
2. Nuclear Reacto General Metallurgy - N. Sevryukov, B. Kuzmin and Y. helishchevr
3. Engineering - S. Glass Stone and A. Sesonske.
4. Nuclear Chemical Engineering - ManstionBendict and Thomas H. Pigfort

III Year I Semester	MAGNETIC AND ELECTRONIC MATERIALS (PROFESSIONAL ELECTIVE – II)	L	P	C
		3	0	3

(**Course objective:** To understand the basic principles and physical origins of magnetic &electronic properties ofmaterials and to study the various materials which exhibit these functional properties)

UNIT-I

*(Learning objective**:** To understand the fundamentals of magnetism and to learn about the various magnetic materials)*

Magnetic Materials: Definition of Magnetic field, Magnetic Induction, Magnetic Field Intensity, MagneticSusceptibility.

Types of Magnetic Materials: Paramagnetic, Diamagnetic, Ferromagnetic, AntiFerromagnetic, Ferrimagneticmaterials.

UNIT-II

*(Learning objective**:** To study about the Theories of magnetism and domain theory of Ferromagnetism)*

Theories of Para, Dia and Ferromagnetism, Curie temperature, Domain theory of Ferromagnetism, Reversible and Irreversible domains. Barkhausen Effect.\

UNIT-III

*(Learning objective**:** To understand the concept of hysteresis loop and the difference between hard and soft magnetic materials)*

Hysteresis loop, Domain Interpretation of Hysteresis curve, interpretation of hysteresis and hand magnetic Materials, differences in magnetic properties of hard and soft magnetic materials, magnetic anisotropy and magneto-striction, GMR (Giant Magnetic Resonance)

UNIT-IV

*(Learning objective**:** To learn about the fundamentals of semiconductors and classification of semiconductors)*

Semi conductors, Band theory and solids, distribution of energy states, classification of semi conductors, intrinsic and extrinsic , n type and p type, variation of carrier concentration with temperature, Hall effect, forward baising and reverse baising semiconductor devices

UNIT-V

*(Learning objective**:** To learn about the various applications of magnetic materials)*

Applications of magnetic materials: soft and hard, high energy hard magnetic materials, magnetic storage, ferritecore memories, bubble memories, piezoelectricceramics, polymers, chemicalsensors, electrochemicalsensors, shapememoryalloys

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities should be tested by class room assessment techniques). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Electronic properties of materials, R E Hummel
2. Ferromagnetic materials structure and properties, R A Macurie
3. Principals of electronic materials and devices by Kasap S.O

Reference Books:

1. An introduction to materials science , HLMancini
2. Magnetic Materials fundamentals and devices, Nicols Spaldin

III Year	NUCLEAR MATERIALS	L	P	C
I Semester	(PROFESSIONAL ELECTIVE – II)	3	0	3

(Course objectives: The objective of this course is to make understand the concepts of Nuclear science and Special Properties required for materials to meet nuclear reactor requirements.)

UNIT – I

(*Learning objectives****:*** *To learn about the fundamentals of nuclear physics, Nuclear interaction and nuclear reactions)*

Elementary Nuclear Physics and Chemistry; Structure of nucleus, radioactivity, binding energy; nuclear interaction; fission and fusion; nuclear reaction; energy release and chain reactions; neutron absorption cross-section; multiplication and criticality concepts and factors.

UNIT – II

*(Learning objectives****:*** *To learn about the various types of reactors and their construction and working principle)*

Reactor components; Types of reactors; PWR, BWR, Graphite Moderator Reactor, Heavy water Reactor, Graphite moderator Reactor, Light Water moderator Reactor, Liquid metal coolant reactor. Mechanisms of moderation, radiation detection, radiation effects on fissile and non-fissile materials; radiation damage and radiation growth; thermal cycling; protection against radiations.

UNIT – III

(*Learning objectives****:*** *To understand about the various materials used in nuclear reactors and their production)*

Materials for nuclear reactors; Considerations in selection and properties of common materials used as fuels, their physical and chemical properties; canning materials; coolants; control rods; reflectors and shielding materials. Production of reactor materials.

UNIT – IV

(*Learning objectives****:*** *To have the knowledge about Occurrence, general characteristics and the processing of nuclear materials)*

Indian resources: Occurrence and general characteristics of nuclear minerals. Flow sheets of processing of nuclear minerals for the production of nuclear grade uranium, thorium, beryllium and zirconium with emphasis on basic scientific principles involved.

UNIT – V

*(Learning objectives****:*** *To understand the production of various nuclear fuel elements and nuclear power production in India)*

Production and enriched uranium and fabrication of fuel elements. Irradiated fuel processing for recovery of Plutonium. Nuclear power production in India and its economics and safety measures.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1.Wright JC -Metallurgy in Nuclear Power Technology; Iliffe Book Ltd.,1962

2.Glasstone S and Snesonske A; Principles of Nuclear Reactor Engineering;

Reference Books:

1.Wilkinson WD and MrphyWFNuclear Reactor Metallurgy Van Nostrand1958

2.Symposium on Rare matierals; Indian Institute ofMetals.

3.Gurinsky DH and Dienes JL NulcearsFuels,Macmillan.

4.Proceedings of the symposium on Nuclear Science and Engineering – Bhabha Atomic Research Centre,Bombay.

III Year	ADVANCED MANUFACTURING TECHNOLOGY	L	P	C
I Semester	(PROFESSIONAL ELECTIVE – II)	3	0	3

(Course objective: This course aims at making student to understand and design a material for a givenapplication considering the composition, manufacturing process and properties that are required inservice.)

UNIT – I

*(Learning objective**:** To understand the machining theory and practice of various materials)*

Advanced machining theory & practices - mechanisms of chip formation, shear angle relations, and theoretical determination of cutting forces in orthogonal cutting; analysis of turning, drilling, and milling operations; mechanics of grinding; dynamometry; thermal aspects of machining; tool wear; economics of machining; processing of polymers, ceramics, and composites.

UNIT- II

*(Learning objective**:** To know about the various advanced machining processes)*

Advanced machining processes – Process principles, Material removal mechanism, Parametric analysis and applications of processes such as ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM), Electrochemical machining (ECM), Electro discharge machining (EDM), Electron beam machining (EBM), Laser beam machining (LBM) processes.

UNIT – III

***(**Learning objective**:** To know about the various advanced forming processes used to fabricate the components)*

Advanced Forming processes - electro-magnetic forming, explosive forming, electro-hydraulic forming, stretch forming, and contour roll forming.

UNIT – IV

*(Learning objective**:** To know about the various advanced welding process to join various materials)*

Advanced welding processes - EBW, LBW, USW; Advanced foundry processes - metal mould, continuous, squeeze, vacuum mould, evaporative pattern, and ceramic shell casting.

UNIT – V

*(Learning objective**:** To know about the additive manufacturing and various advanced manufacturing techniques)*

Additive manufacturing :- Wire Arc additive manufacturing , SLM ,Laser chemical vapour Deposition, Direct metal deposition, Electron beam melting , 3D printing, and Applications.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities should be tested in classes by giving problems on welding . Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Materials and Processes in Manufacturing, E.P. DeGarmo, J. T Black, R.A.Kohser
2. Manufacturing Science, A. Ghosh, and A.K. Mallik,
3. Nontraditional Manufacturing Processes, G.F.Benedict, Marcel Dekker

Reference Books:

1. ASM Hand book, Volume 15; Casting
2. ASM Hand book, Volume 6; Welding
3. ASM Hand book, Volume 16; Machining
4. ASM Hand book, Volume 14; Forming

III Year I Semester	INTRODUCTION TO MATERIALS ENGINEERING (OPEN ELECTIVE – I)	L	P	C
		3	0	3

(Course objective: To develop an understanding of the basic knowledge of Materials Engineering, to gain knowledge on overview of developments in the field of materials over periods and to become familiar with the materials industry.)

UNIT - I
*(Learning objective**:** To know about the classification of materials and various crystal systems)*

Introduction: classification of materials**,** Space lattice and unit cells
Crystal systems: Indices for planes and directions. Structures of common metallic materials.

UNIT – II
*(Learning objective**:** To understand the various crystal defects and slip systems in various crystals)*

Crystal defects: Point, Line and surface defects. Dislocations, types, Burgers' Vector. Dislocation movement by slip, climb and cross slip. Dislocation sources.
Slip systems for BCC, FCC and HCP metals, Critical resolved shear stress (CRSS) for slip, Twinning, Stacking faults, Jogs, Kinks.

UNIT – III
*(Learning objective**:** To understand the fundamental concepts and theories of Optical, Magnetic and Electronic materials)*

Optical, Magnetic and Electronic properties of materials: Refractive index, absorption emission of light, optical fibers. Opto-electronic materials.Dia, para, ferro, ferri magnetism. Soft and hard magnetic materials and applications. Electronic conductivity, free electron theory and band theory of solids. Intrinsic semi-conductors.Super conductivity.

UNIT - IV
***(Learning objective:** To have the knowledge about polymers, their properties and applications)*

Polymers:- Functional polymers and structural polymers.Properties and applications.

UNIT - V
(Learning objective: To understand the various types of ceramics, their properties and applications)

Ceramic Materials:-Introduction to ceramics, structural ceramics and functional ceramics – properties and applications.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text books:

1. Introducton to material science by callister
2. Maerial science by Ashby
3. Material Science and Engineering by V.Raghavan
4. Physical Metallurgy by S. H. Avner.

Reference books:

1. Material Science and Engineering by L.H.VanVleck, 5th edition, AddisionWealey(1985)
2. Structure and properties of Materials by R.M.Rose, L.A.Shepard and J.Wulff, Vol.1,4 John Willey (1966) .
3. Essentials of Material Science by A.G.Guy, McGraw Hill(1976).
4. The Science and Engineering Materials by D.R.Askeland. 2nd Edition, Chapman and Hall (1990).
5. Physical Metallurgy, Vijendra Singh

III Year	BASICS OF CRYSTALLOGRAPHY	L	P	C
I Semester	(OPEN ELECTIVE – I)	3	0	3

(**Course objective:** To study relation between material structure and their properties)

UNIT – I
*(Learning objective**:** to learn about the fundamentals of crystal structure and perform relevant numerical calculation)*

Motif, lattices, lattice points, lattice parameter, Crystal systems,14 Bravice lattices, Coordination number, number of atoms per unit cell, packing factor, Miller indices of planes directions, repeat distance, linear density packing factor along a direction, planar density, planar packing fraction

UNIT – II
*(Learning objective**:** to study about various diffraction techniques used for crystallography)*

Usage of diffraction techniques for crystallography- XRD ,Neutron Diffraction, and synchrotron diffraction.

UNIT – III
*(Learning objective**:** To study about the various type of various interstitial solid solution, compounds and intermetallics)*

Radius ration for coordination number 2,4,6,8. Interstitial solid solution, Interstitial compounds. AX,AX2,AB03 A 2B04 crystal structures

UNIT – IV
*(Learning objective**:** To study the impact of defects on material properties.)*

Frenkel-Schkotty ionic defects, Ionic defect concentration, solute incorporation, Electronic defect concentration, Defects and chemical reactions.

UNIT – V
*(Learning objective**:** To study about the symmetry and crystallography in crystals)*

Symmetry and crystallography. Symmetry in crystals. Rotational symmetry, stereographic projection. Crystallographic point groups, micro translations, symmetry of reciprocal lattice, systematic absences, space groups .

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's learning ability should tested by conducting class room tests. Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text books:

1. Introduction to crystallography, Donald E. Sands, Courier Corporation, 2012

Reference books:

1.The science and Engineering Materials, Donald R. Askeland and Pradeep phule, Thmson,2003

2. Elements of X-ray diffraction, Cullity B.D., Addison-Wesley Publishing company 1956

III Year	METALURGICAL PROCESS MODELLING	L	P	C
I Semester	(OPEN ELECTIVE – I)	3	0	3

(Course objective: To develop the understanding about basic concepts related to metallurgical process modelling, to get hands on experience in some aspects of modelling and to be able to visualize modelling of complex industrial scale metallurgical processes)

UNIT-I

*(Learning objective**:** To know various mathematical models and their advantages)*

Mathematical modeling, physical simulation, advantages and limitations; process control, instrumentation and data acquisition systems, review of transport phenomena, review of differential equations, review of numerical methods;

UNIT-II

*(Learning objective**:** To differentiate finite element and finite differential modelling.)*

Concept of physical domain and computational domain, assumptions and limitations in numerical solutions, introduction to FEM & FDM, Introduction to software packages – useful websites and generic information about different products - ANSYS, Thermocalc, CFD;

UNIT-III

*(Learning objective**:** know the application of artificial intelligence in various metallurgical problems)*

Introduction to expert systems and artificial intelligence; demonstration/practical training in some software packages.

UNIT- IV

*(Learning objective**:** To develop physical models in various metallurgical applications.)*

Physical modeling – cold and hot models; case studies of water models, use of computers for the construction of phase diagrams, alloy design, crystallography, phase transformations and thermo chemical calculations.

UNIT – V

*(Learning objective**:** To analyse different case studies related to process modelling.)*

Case studies from literature – pertaining to modeling of solidification / heat transfer, fluid flow, casting, welding and liquid metal treatment

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Szekely J., Themelis N. J., 'Rate Phenomena in Process Metallurgy', Wiley, 1971
2. P.S. Ghosh Dastidar, "Computer Simulation of Flow and Heat Transfer", Tata McGraw Hill, New Delhi, 1998.

III Year I Semester	CORROSION LAB	L	P	C
		0	3	1.5

(Course objective: This lab course is designed to conduct the experiments on electrodeposition, verification of Faraday's laws and evaluation of factors affecting oncorrosion)

List of experiments:

1. Study the effect of concentration and temperature on conductivity of an aqueous electrolyte (NaCl)
2. Verification of Faraday'slaws
3. Potentio dynamic polarization analysis
4. Impedance analysis.
5. Electroplatingof copper/ nickel/chromium
6. To anodise the given aluminium sample and observation of microstructure
7. To understand the principles in galvanic cell corrosion using "Ferroxyl" indicating test solution.
8. To analyze the stress corrosion behavior of steel
9. To study the intergranular corrosion of Austenitic stainless steels
10. To conduct electropolishingof stainless steel using Nitric acid batch.

List of equipment:

1.Potentio dynamic polarization unit
2.Stress corrosion analysis unit
3.Rectifier
4.Ammeters
5.Rheostats
6.D C Regulated Power Supply instrument
7.Electropolishing Equipment
8.Multimeters
9.Conductometers
10.Digital weighing balance

Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:

I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

II.

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

III Year I Semester	MECHANICAL TESTING LAB	L	P	C
		0	3	1.5

(Course objective: To obtain knowledge on various mechanical testing machines, and mechanical testing methodology.)

List of experiments:

1. To determine the BrinellHardness of ferrous and non-ferroussamples.
2. To determine the Rockwell hardness of ferrous and non-ferroussamples.
3. To determine the hardness of ferrous and non-ferrous samples by using Vickers hardness tester.
4. To Determination of hardness profile across weldments using microvickers hardness tester
5. To determine the elastic modulus, ultimate tensile strength, breaking stress,percentage elongation percentage reduction in area of the given specimen by tensiletest.
6. To determine the compressive strength of metals and alloys.
7. To determine the modulus of rigidity of given material by torsiontest
8. TodeterminetheCharpyandIzod(V&UGroovenotch)impactstrengthofagivenmaterial at room temperature.
9. To determine the fatigue strength of given material at a givenstress
10. To estimate steady state creep rate of materials

List of equipment:

1. Brinell Hardness Machine
2. Vickers Hardness Machine
3. Rockwell Hardness Machine
4. UTM
5. Torsion Testing Machine
6. Impact Testing Machine
7. Fatigue Testing Machine
8. Indentation Creep unit

(Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:

I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

II.

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination

III Year II Semester	MATERIALS CHARACTERIZATION	L	P	C
		3	0	3

(**Course objective:**To impart knowledge in material properties and manufacturing methods. Students will be able to understand various material and its properties and manufacturing methods.)

UNIT –I

*(Learning Objectives**:** To understand various characterization techniques for solids)*

Introduction: Scope of subject, classification of techniques for characterization, macro and micro-characterization structure of solids.

UNIT –II

(Learning Objectives: To understand more characterization techniques.)

Optical & X-ray Spectroscopy: Atomic absorption spectroscopy, X-ray spectrometry, infraredspectroscopy and Raman spectroscopy.

UNIT –III

(Learning Objectives: To understand opticalandElectron methods of characterization)

Opticalmicroscopy: Optical metallography, image analysis, quantitative phase estimation.
Electron microscopy: Scanning electron microscopy ,TEM ,EDS and WDS.
Other microscopy techniques :AFM and STM

UNIT –IV

(Learning Objectives: To know the Diffraction methods of characterization with focus on XRD)

Diffraction Methods: X-ray diffraction (crystal systems and space groups, Bravais lattices, directand reciprocal lattice, Bragg law, powder diffraction and phase identification, single crystal diffraction, structure factor, X-ray crystal structure determination).

UNIT –V

(Learning Objectives: To learn different thermal methods of characterization)

Bulk Averaging Techniques: Thermal analysis, DTA, DSC, TGA, dilatometry, resistivity/ conductivity.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities should be tested periodically in by concept based tests. Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. The Principles of metallogrphy laboratory practices –George L.Khel-Eurasia publishing house (Pvt Ltd)
2. Transmission electron Microscopy of metals –Garet Thomas.-John wiley and sons.

Reference Books:

1. Modern Metallographic Techniques & their application – victor phillips.
2. Physical Metallurgy, Part – I – RW Chao and P. Haasan.
3. Experimental Techniques in Physical Metallurgy – VT Cherepin and AK Mallik.
4. Electron Microscopy in the study of materials –P.J.Grundy.

III Year II Semester	NON DESTRUCTIVE TESTING	L	P	C
		3	0	3

(Course objective: To introduce the various non-destructive techniques for testing and inspection of materials to detect surface, sub-surface and internal defects produced during the fabrication process without destroying them.)

UNIT – I

(Learning Objectives: To understand the various non-destructive techniques for testing and inspection of materials to detect surface defects)

Visual Inspection: Visual Inspection- tools, applications and limitations. Liquid Penetrant Inspection - principles, types and properties of penetrants and developers. Advantages and limitations of various methods of LPI. Magnetic particle inspection- principles, applications, advantages and limitations

UNIT – II

(Learning Objectives: To understand the various non-destructive techniques for testing and inspection of materials to detect sub-surface defects)

Ultrasonic testing: Ultrasonic testing(UT) - Nature of sound waves, wave propagation - modes of sound wave generation - Various methods of ultrasonic wave generation, types of UT Principles, applications, advantages, limitations, A, B and C scan - Time of Flight Diffraction (TOFD)

UNIT – III

(Learning Objectives: To understand the various non-destructive techniques for testing and inspection of materials to detect internal defects)

Radiography: Radiography testing (RT) – Principles, applications, advantages and limitations of RT. Types and characteristics of X ray and gamma radiation sources, Principles and applications of Fluoroscopy/Real-time radioscopy - advantages and limitations - recent advances.

UNIT - IV

(Learning Objectives: To understand the various non-destructive techniques for testing and inspection of materials to detect sub-surface defects)

Eddy current testing: Eddy current testing - Principles, types, applications, advantages and limitations of eddy current testing.

UNIT – V

(Learning Objectives: To understand the various non-destructive techniques for testing and inspection of materials to detect internal defects)

Thermography: Thermography - Principles, types, applications, advantages and limitations. Optical & Acoustical holography- Principles, types, applications, advantages and limitations. Case studies: weld, cast and formed components.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's learning ability should be developed by making them study some case studies)

Text books:
1. Non-Destructive Testing by P. Halmshaw

Reference Books:
1. Metals Handbook Vol.II, Nondestructive inspection and quality control
2.Practicalnon destructive testing by Dr.BaladevRajan

III Year II Semester	POWDER METALLURGY	L	P	C
		3	0	3

(Course objective: To understand the fundamentals of manufacturing methods in the view of metallurgical perspective with reference to engineering applications)

UNIT – I
(Learning Objective: To get acquainted with the importance of powder metallurgy and to know the advantages of PM techniques over other fabrication techniques)

Introduction: Emergence and importance of powder metallurgy**,** Comparison of powder metallurgywith other fabrication techniques, its scope and limitations.

UNIT – II
(Learning Objective: To get acquainted with various powder production methods and also get an idea of powder characterization.)

Characterization and production of powders: General characteristics of metal powders, particleshape flow rate, apparent density, and specific surface area, particle size distribution.
Determination of powder characteristics; different methods of production of metal powders:influence of manufacturing process on powder characteristics.

UNIT – III
(Learning Objective: To study the mechanism of compaction and sintering.)

Consolidation of Metal Powders: Compaction - Theory of consolidation: Pressure transmissioninpowders; compressibility and compactibility of powders; Green strength; Powder rolling. Sintering - Mechanisms of Sintering; Factors affecting sintering; Activated sintering; Liquid phase sintering; Sintering atmospheres; Properties of sintered parts, Hot isostatic pressing , spark palsma sintering. Properties of sintered parts.

UNIT – IV
(Learning Objective: To gain knowledge on various applications of powder metallurgy parts.)

Applications: Porous parts: Self-lubricating bearings, filters: Dispersion strengthened materials: Cu /Al2O3, Sintered Aluminum Powder.

UNIT –V
(Learning Objective: To get acquainted with the advanced powder metallurgy materials.)

Electrical and Magnetic materials, Tungsten lamp filaments, electrical contacts, welding electrodes.Soft magnetic materials (Fe, Fe-N); Permanent magnets (Alnico, SnCo5), Cemented carbides; Cermets.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's understanding should be tested periodically in classes).

Text Books:

1. Powder Metallurgy: Anish Upadhya and GS Upadhya- University Press, 2013
2. Powder Metallurgy, P.C. Angelo and R. Subramanian, PHI Pvt. Ltd., 2008
3. Powder Metallurgy and particulate materials processing by RM German

References Books:

1. Powder Metallurgy, ASM Metals Hand Book , Vol. 7, 1984
2. Powder Metallurgy Science, Randall M. German, 1994

III Year II Semester	SURFACE ENGINEERING AND TRIBOLOGY (PROFESSIONAL ELECTIVE – III)	L	P	C
		3	0	3

(**Course objective:**To get exposed to various concepts of surface engineering methods and attain comprehensive knowledge in offering suitable solutions to industrial problems)

UNIT – I
(Learning objective: To explore different surface electrochemical reactions)

Chemical and electrochemical polishing, significance, specific examples, chemical conversion coatings, phosphating, chromating, chemical colouring, anodizing of aluminium alloys, thermochemical processes -industrial practices

UNIT – II
(Learning objective:To learn different electrochemical coating methods)

Surface pre-treatment, deposition of copper, zinc, nickel and chromium-principles and practices, alloy plating, electro composite plating, properties of electrodeposits, electroless, electroless composite plating; application areas, properties.

UNIT – III
(Learning objective: To understand different physical coating methods)

Definitions and concepts, physical vapour deposition (PVD), evaporation, sputtering, ion plating, plasma nitriding, process capabilities, chemical vapour deposition (CVD), metal organic CVD, plasma assisted CVD.

UNIT – IV
(Learning objective: To understand different thermal spray coatings and various surface laser techniques)

Thermal spraying, techniques, advanced spraying techniques- plasma surfacing, detonation gun and high velocity oxy-fuel processes, laser surface alloying, laser cladding, specific industrial applications, tests for assessment of wear and corrosion

UNIT – V
(Learning objective:To understand various surface degradation phenomena)

Introduction to tribology, , types of wear, adhesive, abrasive,oxidative, corrosive, erosive and fretting wear, roles of friction and lubrication

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's learning abilities should be tested by assessing group work. Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. 'Surface modification technologies - An Engineer's guide' SudarshanTS, Marcel Dekker, Newyork, 1989
2. VargheseC.D, 'Electroplating and Other Surface Treatments- A Practical Guide', TMH,1993
3.Surface engineering br D SRINIVASA RAO AND S.V.JOSHI

III Year II Semester	TRANSPORT PHENOMENON (PROFESSIONAL ELECTIVE – III)	L	P	C
		3	0	3

(Course objective: To understand basic concepts related to heat flow, fluid flow, mass transfer, in the context of metallurgical processes; to become familiar with the mathematical treatment and equations related to above transport phenomena).

UNIT – I
(Learning objective:To understand basic concepts related to fluid flow in the context of metallurgical processes)

Fluid Flow ,Viscosity, differential mass and momentum balances, overall momentum balance, mechanical energy balance, applications

UNIT - II*:*
(Learning objective:To understand basic concepts related to heat transferin the context of metallurgical processes)

Heat Transfer ,heat conduction equation, applications, steady and transient heat conduction, Two dimensional heat conduction

UNIT – III
(Learning objective: To understand basic concepts related to convectiveheat transferin the context of metallurgical processes)

Convective heat transfer, concept of heat transfer coefficient, forced and free convection, Radiation, view factor, radiative heat exchange between surfaces

UNIT – IV
(Learning objective: To understand basic concepts related tomass transferin the context of metallurgical processes)

Mass Transfer, Diffusion: Diffusivity in gases, liquids, solids, convective mass transfer, concept of mass transfer coefficient

UNIT – V
(Learning objective: To understand familiar with the mathematical treatment and equations related to above transport phenomena; to comprehend the science behind process modeling)

Dimensionless analysis, Rayleigh's method, Buckingham method, use of differential equations, similarity criteria, applications in physical modelling

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1.Transportphenomena,2ndEdition:R.ByronBird,WarrenE.StewartandEdwinN Lightfoot; John Wiley &Sons
2.FundamentalsofMomentum,HeatandMassTransfer,4thEdition:JamesR.Welty,Charls E. Wicks, Robert E. Wilson and Gregory Rorrer; John Wiley &Sons

Reference Books:

1. Transport phenomena in materials processing : D.R. Poirier and G.H. Geiger,TMS
2. Introduction to Fluid Mechanics, 5th Edition: Robert W. Fox & Alan T. McDonald: John Wiley & Sons.

III Year II Semester	ALTERNATE ROUTES OF IRON AND STEEL MAKING (PROFESSIONAL ELECTIVE-III)	L	P	C
		3	0	3

(**Course objectives:**To learn alternate routes of iron making based on coal based, gas-based processes, to gain knowledge about important smelt reduction processes and to enhance the technical knowledge in secondary steel making processes.)

UNIT - I
(Learning Objectives: To know the availability and preparation of iron ores.)

Processing of raw materials, Coke making, processing of lime and dolomite stone. Iron ore processing and agglomeration techniques

UNIT – II
(Learning Objectives: To understand the Modern trends in Blast Furnace Operation *and alternative routes o iron production)*

Iron making: Modern trends in Blast Furnace Operation, alternative routes of Iron Production (COREX, MBF), direct reduction process: HYL, SL/RN processes, Midrex process, fluidized bed.

UNIT – III
(Learning Objectives: To understand about various types of raw materials used for steel making andabout various steel making processes)

Steel making: Fundamentals of steel making, BOF steel making, Electric furnace steel making, Hybrid steel making processes, Ajax, Twin hearth, Tandem, SIP, OBM, high tension electric steel making, plasma arc steelmaking processes.

UNIT –IV
(Learning Objectives: To understand the principles of steel making by modern methods.)

Advanced techniques in steel making: WORCRA, IRSID, Spray steel making, INRED, ELRED processes. Production of High purity steel: Non-metallic inclusions and their effect on properties of steel. Refining techniques, ESR, VAR, and Vacuum Degassing of liquid steel. Alloy steel making, Tool steels and stainless steel making practice. Review of Iron and steel Industry in India.

UNIT – V
(Learning Objectives: To understand the principles of Solidification of steels and various Ingotdefects.)

Solidification and casting operations: Principles of solidification of steel, ingot casting, continuous casting, modelling of steel making process.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Reduction of Iron Ores – VAN BOGDANDY.
2. Aspects of Modern ferrous Metallurgy – J.S.KIRKALDY & G.WARD.

Reference Books:

1. IIM-Silver Jubilee Symposium on Recent Developments in Materials Science and Technology.
2. Making, Shaping Treating of Steel published by United States Steel Corporation.
3. Introduction of Modern Iron Making – R.H.TUPKARY.
4. Introduction of Steel making – R.H.TUPKARY
5. Iron making and steel making-Ahindra Ghosh and Amit chatterjee, PHI Learning Pvt Ltd.

III Year II Semester	MATERIALS TESTING (OPEN ELECTIVE-III)	L	P	C
		3	0	3

(Course objective: To know the fundamental concepts of various mechanical testing practices)

UNIT- I
*(Learning Objective**:** The topic deals with various types of dislocations, slip and twinning*)

Metallurgical Fundamentals: Critical resolved shear stress. Defects in crystalline materials The concept and types of dislocation, Interaction between dislocations, sessile dislocation, glissile dislocation, Energy of a dislocation, dislocation climb, Jogs, Forces on dislocations. Frank Reed source, slip and twinning.

UNIT- II
(Learning Objective: To understand the principles of various hardness tests and theories of fracture)

Hardness Test: Methods of hardness testing Brinell, Vickers, Rockwell, Rockwell superficial, Shoreand Poldi methods, Microhardness test, relationship between hardness and other mechanical properties.
Impact Test: Notched bar impact test and its significance, Charpy and Izod Tests, , significance of transition temperature curve, Metallurgical factors affecting on transition temperature, temper embrittlement.

UNIT – III
(Learning Objective: To understand the principle of tensile test, compression Test etc)

Tension Test: Mechanism of elastic action, linear elastic properties. Engineering stress strainand True stress-strain curve. Tensile properties, conditions for necking, effect of temperature and strain rate on tensile properties.
Compression Test: Elastic and in-elastic action in compression, elastic and in-elastic properties in compression.

UNIT – IV
(Learning Objective: To know the fundamentals, failure and the factors affecting fatigue and creep.)

Fatigue Test: Introduction, Stress cycles, S-N Curve, Effect of mean stress, Mechanismof fatigue failure, effect of stress concentration, size, surface condition and environments on fatigue. Effect of metallurgical variables on fatigue.Low cycle fatigue - High cycle fatigue.
Creep Test: creep curve, Stress-rupture test, Structural changes during creep, Mechanism of creep deformation, theories of creep. Fracture at elevated temperature, Effect of Metallurgical variables on creep.

UNIT- V
(Learning Objective: To know the non-destructive testing methods and evaluation of flaws inmaterials)

Non-Destructive Tests: Introduction, various NDT methods, applications advantages of one test over the other.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student learning abilities should be tested by classroom assessment techniques.)

Text Books:
1. Mechanical Metallurgy - GE Dieter

Reference Books:
1. Engineering Materials Science - CW Richards
2. Mechanical behavior of material-A.H.Courteny
3. Mechanical behavior-Ed.Wulf.

III Year II Semester	CHEMICAL ANALYSIS OF METALS (OPEN ELECTIVE-III)	L	P	C
		3	0	3

(**Course objective:** To study the methods of analysis of various metals and alloys quantitatively and qualitatively.)

UNIT – I
(Learning objective: To know the importance of various methods of Metallurgical anaslysis.)

Importance of chemical analysis, scope of analysis of metalss, classification of various methods used in metallurgical analysis.Solution preparations, normality, molarity, molality, Equivalent weight.Dissolution of ores in general, dissolution of metals and alloys.

UNIT - II
(Learning objective: To know the various methods of qualitative analysis of ores and metals)

Chemical Analysis, Basic Principles, theory of indicators, Conventional solution methods for qualitative analysis of ores, fluxes, slags, metals and refractories.

UNIT-III
(Learning objective: To know the various methods of qualitative analysis of a few ferrous and non-ferrous metals and alloys)

Qualitative analysis of common non-ferrous alloys such as brasses, bronzes and solders. Estimation of C, S, Si, Mn and P in cast iron and steel.

UNIT-IV
(Learning objective: To estimate various elements present in various ores)

Estimation of Cr, Ni, Mo, W and V in alloy steels. Determination of iron in iron ore, manganese in manganese ores, lime in limestone, fire-assay of precious metals.

UNIT-V
(Learning objective: To describe various instrumental methods of analysis and to compare the results with different wet methods)

Instrumental analysis, Comparison with standard wet chemical methods, Spectroscopy, potentiometry, amperometric titration. Calorimetric titrations, polarography, conductometry, electro-analysis and flame photometry.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. S.K.Jain-Metallurgical analysis.

Reference Books:

1. Iyer V.G., Metallurgical Analysis: BHU Press, Varanasi.
2. Agarwal, B.C. and Jain S.P., A Text Book of Metallurgical Analysis, Khanna Publishers, Delhi
3. Snell Foster D and Frank M Biffen: Commercial methods.of analysis / Che. Publishing

III Year II Semester	MATERIALS FOR EXTREME ENVIRONMENT (OPEN ELECTIVE-III)	L	P	C
		3	0	3

(**Course Objective:**Student should be capable of understand various extreme environment conditions and choose suitable materials for various conditions.)

UNIT – I
(Learning objective: To know the fundamentals of creep, Creep curve , factors effecting creep and creep resistant materials)

Fundamentals of high temperature deformation, creep mechanism, Deformation Mechanism Maps, Super-plasticity.
Engineering materials applied in extreme environments, structural materials at high temperatures such as gas turbine applications

UNIT – II
(Learning objective: To know about radiation ,effect of radiation on materials, different radiation resistant materials)

Introduction radiation resistance materials; radiation damage, half-life period, irradiation damage resistance, BCC structures and ferritic grade steels for radiation damage resistance applications, Liquid sodium storage materials in nuclear industry.

UNIT – III
(Learning objective: To know about properties of materials used in aerospace industry)

Space environment, anomalous behavior of materials in spacespacecraft materials, reusable space vehicles, carbon-carbon composites (CCC).

UNIT – IV
(Learning objective: To learn high temperature behaviour of various high temperature materials and design new materials for high temperature applications)

Understanding high strain rate deformation, Elastic wave propagation, Materials under thermo-mechanical extremes (static vs dynamic, high-pressure phases, shock detonation, cavitation, super-cooled liquids and glasses), Shock resistant materials, armor grade materials.

UNIT – V
(Learning objective: To know about properties of materials used in cryogenic applications)

Materials for cryogenic applications, DBTT, FCC structures, Deformation behavior in cryogenic temperatures.

(Assessment: The student should be evaluated based on the objective tests. The student's analytical abilities) should be tested periodically in classes by giving assignments). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Book:

1. Materials Under Extreme Conditions, Vincenzo Schettino and Roberto Bini, Imperial College Press, winter 2012.

Reference Books:

1. Mechanical Metallurgy, G.E. Dieter, Mc Graw Hill Publishers, NY,2002

III Year II Semester	FERRO ALLOY TECHNOLOGY	L	P	C
		3	0	3

(**Course objective:** The main scope and objective is to obtain knowledge over the properties, production and applications of various ferro alloy materials)

UNIT-I
(Learning objective: To obtain knowledge over the importance of ferro alloys and present status of ferro alloys in India)

Introduction: Types of Ferro alloys and their uses: Present status of ferroalloy industry in India.Future plans and developments.
Lay out: Lay out of a ferro alloy plant and its production economics.

UNIT-II
(Learning objective: To obtain knowledge over the ferro alloy production and the physico chemical aspects involved)

Principles: Physicochemical aspects of ferroalloys. Production by various methods.

UNIT-III
(Learning objective: To study and learn about various furnaces used for production of ferro alloys)

Furnace types and its design, refractories, auxiliaries, power supply.Working voltage, power factor and efficiency.

UNIT-IV
(Learning objective: To study and learn about various production methods of ferro alloys)

Production: Production of ferro-silicon-calcium, ferromanganese (high and low carbon), Ferro-chrome(high and low carbon),Ferro-molybdenum.

UNIT-V
(Learning objective: To study in detail about the production of ferro tungsten, ferro titanium and ferro vanadium)

Ferro-tungsten,ferro-titanium,ferro-vanadium.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's learning abilities (with special focus on academically weak students) should be tested periodically by asking to discuss some case studies))

Text Books:
1. A. Riss and Y. Khodorovsky , Production ferroalloys Mir Publishers,Moscow 1967.
2. B. P. Bharadwaj, The complete book on ferroalloys, NIIR Project consultancy services, 2014

Reference Books:
1. Hand book of Ferro alloys: theory and technology Edited by Michael Gasik, BH publishers, 2013

III Year II Semester	MATERIALS CHARACTERIZATION LAB	L	P	C
		0	3	1.5

(**Course objective:**To enable the students to understand about the principles of materials characterization.)

List of Experiments:

1. Optical microscopy – observing bright field and dark field imaging through optical microscope
2. Optical microscopy – grain size measurement
3. Optical microscopy- inclusion analysis in steel
4. X-ray diffractrometry- phase identification
5. X-ray diffractrometry- crystal structure determination and precise lattice parameter measurement
6. X-ray diffractrometry- crystallite size and lattice strain measurement
7. Electron microscopy-fractography analysis
8. Electron microscopy-BSE imaging in composite microstructures
9. Microchemical analysis using EDS
10. Thermal analysis- TG, DTA and DSC analysis for determining thermodynamic parameters

List of Equipment:

1. Metallurgical microscope with image analysis.	1 No.
2.X-ray diffractometer	1 No.
3.Scanning electron microscope with energy dispersive X-ray spectrometer	1 No.
4.Simultaneous thermal analyser	1 No.

(Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:

I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

II.

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

III Year II Semester	NON-DESTRUCTUVE TESTING LAB	L	P	C
		0	3	1.5

(**Course objective:**To provide hands on exposure to students on various non-destruction evaluation techniques.)

List of Experiments:

1. Visual inspection-unaided and aided
2. Liquid penetrant inspection
3. Magnetic particles inspection
4. Eddy current testing
5. X-Ray Radiography
6. Identification and study of welding defectsandcasting defects using radiography
7. Calibration of time base using normal probe
8. Study of IIW blocks and Reference Blocks
9. Ultrasonic testing for defects in welds/castings, etc.,
10. Ultrasonic thickness measurement

List of Equipment:

1.Liquid penetrant test equipment	1 No
2.Magnetic Particle Inspection System	1 No
3.Eddy Current Tester	1 No
4.X-Ray Machine and Film processing setup	1 No
5.Ultrasonic Flaw Detector With Probes	2 No

(Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:

I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

II.

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

IV Year I Semester	MATERIALS JOINING TECHNOLOGY	L	P	C
		3	0	3

(Course objective: To know the concepts of different materials joining technology and emphasis on underlying science and engineering principle of every processes)

UNIT – I
(Learning Objectives: To know the working principle, variables of welding process, microstructure changes in weld zone)

The principles and theory, mechanism and key variables of different welding processes, types of tooling and equipment. Microstructure of fusion and heat affected zone, welding stresses, pre and post treatments.

UNIT-II
(Learning Objectives: To know the working principle, merits and demerits of fusion welding processes.)

Advantages, disadvantages and field of application of the welding with reference to the following welding processes, Gas welding, Arc welding, submerged arc welding, TIG, MIG, Plasma arc welding.

UNIT – III
(Learning Objectives: To Understand the working principle and importance of welding allied processes.)

Electron Beam welding , spot-welding, Laser welding, diffusion joining, Friction welding,Friction stir welding,ultrasonic welding and explosive welding, MIAB welding

UNIT-IV
(Learning Objectives: To know the weldability and welding related problems of ferrous materials , various defects of welds.)

Welding of structural steel, welding of cast iron, welding of stainless steel and other high-alloyed steels. Welding defects and remedies

UNIT-V
(Learning Objectives: To Learn weldability of various Non ferrous alloys .)

Welding of copper and its alloys, welding of aluminum and its alloys, joining of dissimilar alloys mechanism, Techniques and scope of brazing, soldering and adhesive bonding processes.

(Assessment: The student should be evaluated based on the objective tests. The student's analytical abilities should be tested periodically by giving assignments). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Book:
1. Welding Technology-R.S.Parmar**.**
2. A Textbook welding technology by O.P Khanna
3. Welding and welding technology by R L Little

Reference Books:

1. JF Lancaster: Welding Metallurgy
2. Little: Welding and Welding Technology
3. Agarwal Manghmani: Welding Engineering
4. BE Rossi: Welding Engineering

IV Year I Semester	COMPOSITE MATERIALS	L	P	C
		3	0	3

(Course objective: This subject deals with advantages, applications of various types of Composites,and their manufacturing methods.)

UNIT-I
(Learning Objectives: To know various types of composite materials and their applications)

Introduction - Classification of composite materials based on structure, matrix andreinforcement. Advantages of composites - application of composites - functional requirements of reinforcement and matrix.

UNIT- II
(Learning Objectives: To Learn various types of fibers and their role as reinforcement in matrix material)

Fibers: Preparation, properties and applications of glass fibers, carbon fibers, Kevlar fibers and metal fibers-properties and application of whiskers, particle reinforcements.

UNIT- III
(Learning Objectives: To Learn different processing methods of composites.)

Manufacturing of advanced composites: Polymer matrix composites: Preparation of Moulding compounds and – hand lay up method – Autoclave method - Filament winding method - compression moulding – Reaction injection moulding.

UNIT- IV
(Learning Objectives: To learn different processing methods based on their application.)

Manufacturing of Metal Matrix Composites: Casting-Solid state diffusion technique. Cladding – Hot isostatic pressing. Manufacturing of Ceramic Matrix Composites: Liquid Metal infiltration-Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving

UNIT- V
(Learning Objectives: To understand how composites behave under various stress conditions.)

Response of Composites to Stress: (a) Iso strain condition (b) Iso Stress condition (c) Load friction shared by the fibers

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Composite Materials-K.K.Chawla, Springer, 2nd Edition, 1998
2. An introduction to composite materials, D. Hull an T.W. Clyne, 2nd edition, Cambridgeg University press, 1996

Reference Books:

1. Composites ASM Hand Book, Vol. 21, 9th edition, 1989
2. Fundamentals of composites: Materials, manufacturing, methods an applications, Society of manufacturing engineers, 1989
3. Material Sciences and Technology – (R.. W. Cahn, P. Haasen, E, J, Kramer eds.) Vol 13
4. Structure and properties of composites (T. W. Chou ed.) VCH Winheim, 1993 – Composites by Cahn – VCH

IV Year I Semester	SOLIDIFICATION PROCESSING (PROFESIONAL ELECTIVE-IV)	L	P	C
		3	0	3

(Course outcomes: To analyze solidification processing of engineering materials in terms of the phase equilibrium,transport, and interface phenomena governing microstructure development in liquid-solid transformations.)

UNIT-I
(Learning Objectives: To understand thermodynamic principles relevant to solidification)

Introduction and important thermodynamic functions: Laws of thermodynamics-enthalpy, heat capacity, applications of first law to open and closed systems including chemical reactions; entropy, free energy and their interrelationships

UNIT-II
(Learning Objectives: To understand thermodynamic principles relevant to nucleation and growth)

Thermodynamics of solidification; Nucleation and growth; Pure metal solidification, Alloy Solidification, Constitutional undercooling, Mullins-Sekerka instability; Single phase solidification: Cellular and Dendritic growth; Multiphase solidification: eutectic, peritectic and monotectic;

UNIT-III
(Learning Objectives: To Understand the thermodynamics of solutions, principles of free energy minimization and quasi chemical theory)

Heterogeneous systems –equilibrium constants, Ellingham-Richardson diagrams, predominant area diagrams, principles of free energy minimization; energy balance of industrial systems; solutions-chemical potential, Raoult/Henry's law, Gibbs-Duhem equations, regular solutions, quasi chemical theory

UNIT-IV
(Learning Objectives: To analyze the binary, ternary and multi component phase diagrams to determine various thermodynamic parameters)

Evolution of Phase diagrams -phase rule, free-energy-composition diagrams, solidus-liquidus lines, retrograde solidus; determination of activity and other thermodynamic parameters from phase diagrams; thermodynamic analysis of ternary and multi component systems, interaction parameters

UNIT- V
(Learning Objectives: To learn the importance of interface energy and shape on segregation)

Principles and applications of molten slags and silicate melts; electrochemical methods and applications, aqueous systems; Interfaces-energy, shape, segregation at external and internal interfaces; solid electrolytes; Effect of high pressure on phase transformations.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1.Solidification Processing; Fleming, M.C., McGraw-Hill, N.Y., 1974

Reference Books:

1. Fundamentals of Solidification by Kurz, W. and Fisher, D.J., Trans-Tech Pub, Switzerland, 1989

IV Year I Semester	METALLURGICAL FAILURE ANALYSIS (PROFESIONAL ELECTIVE-IV)	L	P	C
		3	0	3

(**Course Objective**: To impart knowledge on the analysis of the probability of failure under various service conditions and methods to ensure safety)

UNIT – I
(Learning Objectives: To know the sources, types and microscopic features of different types of fracture)

Stages of failure analysis, classification and identification of various types of fracture.Overview of fracture mechanics, characteristics of ductile and brittle fracture.

UNIT – II
(Learning Objectives: To understand the factors influence on the fatigue and creep failures and their remedial measures.)

General concepts, fracture characteristics revealed by microscopy, factors affecting fatigue life Creep, stress rupture, elevated temperature fatigue, metallurgical instabilities, environmental induced failure. Some case studies of failures.

UNIT – III
(Learning Objectives: To know the role of various factors on the wear and corrosion failures)

Analysis of wear failure. Corrosion failures- factors influencing corrosion and wear failures, Procedure for analyzing wear and corrosion failures, various types of hydrogen damage failures. Some case Studies

UNIT – IV
(Learning Objectives: To Identify the causes for failures in castings, forgings and weldments)

Causes of failure in forming, failure of iron and steel castings, improper heat treatment, stress concentration and service conditions. Failure of weldments - reasons for failure procedure for weld failure analysis. Some case Studies

UNIT – V
(Learning Objectives: To understand how we can carry out failure analysis and life testing using mathematical methods)

Reliability concept and hazard function, life prediction, condition monitoring, application of Poisson, exponential and Weibull distribution for reliability, mean time analysis between failures and life testing.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Colangelo V.J. and Heiser F.A., Analysis of Metallurgical Failure, 2nd 1987 edition, Wiley-Inter science
2. Metallurgical Failure Analysis Techniques and Case Studies by K P Balan, BS publication 2019 Edition

Reference Books:

1. Shipley R.J. and Becker W.T., Failure Analysis and Prevention, ASM handbook, Vol. 11, ASM International 2002
2. Powell G.W. and Mahmoud S.E., Failure Analysis and Prevention, Metals Handbook, Vol. 11, 9th 1986 edition, ASM International

IV Year I Semester	POLYMER SCIENCE AND TECHNOLOGY (PROFESSIONAL ELECTIVE-IV)	L	P	C
		3	0	3

(**Course objective:** The main scope and objective is to obtain knowledge over the properties, production and applications of various polymeric materials)

UNIT-I
(Learning Objectives: To understand Different kind of polymers and their properties)

Introduction to polymers and plastics: Conception of polymers, formation of polymers, types ofpolymers reactions such as addition and condensation, Mechanism of polymerization - Thermoplastic and Thermosetting materials methods of polymerization.natural rubbers and synthetic rubbers

UNIT –II
(Learning Objectives: To leran classification of polymers and Concept of Molecular Weight and distribution)

Polymeric structure, raw materials and properties - Classification of polymers, raw materials forpolymers and their sources.Brief study of structure of polymers and properties.Crystallinity of polymeric materials, effect of time, temperature, catalysts and solvents on polymer properties, molecular weight of polymers.

UNIT – III
(Learning Objectives: To understand the role of additives used in polymers)

Functions of the following types of additives used in Polymers - fillers,lubricants,reinforcingagents,plasticizers,stabilizers,antioxidants,inhibitors,promoters,catalysts ,retarders,limitators,colorants, cross-linking agents, blowing agents, photodegradiants, bio-degradiants, laminated polymers.

UNIT- IV
(Learning Objectives: To understand thermo plastic and thermosetting polymers)

Thermoplastics -Methods of addition polymerization, raw materials, manufacturing methods, properties and uses of the Important Thermoplastic Polymers
Thermosetting resins - Methods of condensation polymerization, raw materials, manufacturing method, properties and uses of the important Thermosetting Polymers.

UNIT – V
(Learning Objectives: To learn the processing methods of polymers uses of various important polymers)

Raw materials, manufacturing methods, properties and uses of the following plastics Acetals, Nylons, Polymethyl, Methocrylate (PMMA), Saturated polysters – PETP and PC, Cellulose acetate and viscose rayon.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities should be tested periodically in classes by using class room assessment techniques)

Text Books:

1. The elements of polymer science and engineering, Rudin A, Academic Press, 3rd edition, 2013
2. Introduction to polymers, R.J. Young and P. A. Lovell, CRC Press, 3rd edition , 2013

Reference Books:

1. Polymers hand book, J, Brandrup and E. H. Emmergut Wiley-Interscience 4th edition, 1999
2. Material Science and Metallurgy for Engineers –V.D.Kodgire and S. V. Kodgire, Everest Publishers, 2011
3. Callister's Mateials Science and Engineering, Adapted by R.Balasubramaniam, second edition, Wiley, 2015

IV Year I Semester	FUNCTIONAL MATERIALS (OPEN ELECTIVE-III)	L	P	C
		3	0	3

(**Course objective:** The main scope and objective is to obtain knowledge over the properties, production and applications of various functional materials)

UNIT – I

(Learning Objectives: To learn crystal structure of materials and how structure can be relate to properties)

Characteristics and types of functional materials.Crystal structure and Properties.
Effect of size on properties, effect of interfaces on properties. Magnetic materials and storageapplications.

UNIT – II

(Learning Objectives: To understand phenomena of magnetic materials)

High Temperature Behaviour of Amorphous and Nano crystalline Soft Magnetic Materials, Magnetic storage devices to store data using combination of magnetic fields and binary data.

UNIT – III

(Learning Objectives: To understand the semi conductivity and its applications with respect to materials aspects)

Basics of semiconductor electrical properties, operation of the semiconductor devices.Semiconductor devices – Theory, examples and applications of optically active materials Band structure, Diode, MOS device capacitor, MOS transistor structure operation ,Transistor formation and Transistor isolation

UNIT – IV

(Learning Objectives: To know about the concepts related to Di electric and ferro electric materials)

Dielectrics, piezo and ferroelectric materials, High strain high performance piezo- andferroelectric single crystals; Electric field-induced effects and domain engineering; Morphotropicphaseboundary related phenomena; High power piezoelectric and microwave dielectric materials; Nanoscalepiezo- and ferroelectrics.

UNIT – V

(Learning Objectives: To Understand the effect of structures on the properties and applications of Smart materials)

Smart materials: Introduction, definition, factors affecting properties of smart materials.
Applications in electronic, communication, aerospace, automotive, energy industries.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities should be tested periodically in classes by giving problems and by conducting course review class discussions in class)

Text Books:

1. Functional Materials: Electrical, Dielectric, Electromagnetic, Optical and Magnetic applications;Deborah D L Chung, World Scientific Publishing, 2010

Reference Books:

1. Functional Materials 1st Edition, Preparation, Processing and Applications by S. Banerjee, A.K.Tyagi.
2. Advanced Functional Materials by Woo, Hee-Gweon, Li, Hong.
3. Functional Materials: Properties, Performance and Evaluation by EwaKlodzinska.

IV Year I Semester	HIGH TEMPERATURE MATERIALS (OPEN ELECTIVE-III)	L	P	C
		3	0	3

(Course objective: To learn damage mechanism and failure of components of elevatedtemperatures**)**

UNIT- I

(Learning Objectives: To Understand the Creep phenomena at elevated temperature)

CREEP: Introduction to Creep, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate.Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship.

UNIT –II

(Learning Objectives: To understand oxidation and corrosion effect on materials due to elevated temperatures)

OXIDATION AND HOT CORROSION

Oxidation, Pilling, Bedworth ratio, kinetic laws of oxidation- defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion, interaction of hot corrosion and creep, methods of combat hot corrosion.

UNIT-III

(Learning Objectives: To know properties of different alloy steels and to understand how they are used for high temperature applications)

HIGH TEMEPRATURE STEELS

Cr-Mo Steels,Cr-Mo-V Steels, Austentic Stainless Steels, Ferritic steels for Irradiation damage control,ODS Steels Proceesing ,Properties and Applications

UNIT-IV

(Learning Objectives: To know properties of different super alloys)

SUPERALLOYS

Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase,Embrittlement, solidification of single crystals.

UNIT –V

(Learning Objectives: To Understand the effect of thermal barriers coatings)

CERAMICS AND THERMAL BARRIER COATINGS

Alumina, Zirconia, Silicon carbide, Silicon Nitiride,Glass Ceramics

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities should be tested periodically in classes by giving problems and by conducting course review class discussions in class)

Text Books:

1. Callister's Mateials Science and Engineering, Adapted by R.Balasubramaniam, second edition, Wiley, 2015
2. Courtney T.H, "Mechanical Behavior of Materials", McGraw-Hill, USA, 1990.

Reference Books:

1. G. W. Meetham and M. H. Van-de-Voordee, Materials for high temperature applications, Springer 2000
2. Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for Metals, USA, 1985.
3. Hertzberg R. W., "Deformation and Fracture Mechanics of Engineering materials", 4th Edition, John Wiley, USA, 1996.
4. Boyle J.T, Spencer J, "Stress Analysis for Creep", Butterworths, UK, 1983

IV Year I Semester	BIO-MATERIALS (OPEN ELECTIVE-III)	L	P	C
		3	0	3

(Course Objective: To impart knowledge on structure-property relationship in biomaterials and their applications as implants)

UNIT – I
(Learning Objectives: To learn history and common use of biomaterials)

Introduction: Historical background, construction materials, impact of biomaterials, strength of biological tissues, performance of implants, tissue response to implants, interfacial phenomena, safety and efficacy testing

UNIT – II
(Learning Objectives: To understand common use of metals, ceramics as biomaterials)

Metallic and Ceramic materials: Stainless steels, Co-Cr alloys, Tibased alloys, Nitinol, biological tolerance of implant metals, ceramic implant materials, alumina, Zirconia, hydroxyapatite, glass ceramics , restorable ceramics, composites, Degradation of Materials in the biological environment, degradation effects on metals and ceramics,

UNIT – III
(Learning Objectives: To understand common use of polymers as biomaterials)

Polymeric implant materials: Polymers in biomedical use, polyethylene, polypropylene, acrylic polymer, hydrogels, polyurethans, polyamides, biogradable synthetic polymers, silicon rubber, microorganisms in polymeric implants, polymer sterilization, Chemical and biochemical degradation of polymers,

UNIT – IV
(Learning Objectives: To know about the materials used for dental applications)

Dental Materials: Tooth composition and mechanical properties, impression materials, bones, liners, and varnishes for cavities, filling and restorative materials, oral implants, use of collagen in dentistry.

UNIT – V
(Learning Objectives: To understand about the advanced bio materials used for specific applications)

Cardiovascular and Orthopedic implants: Artificial heart, aorta and valves, geometry of circulation, vascular implants, cardiac pace makers, bone composition and properties, fracture healing, joint replacement, knee joint repair, bone regeneration with restorable materials.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities should be tested periodically in classes by using class room assessment techniques)

Text Books:

1. Bhat, S.V., Biomaterials, 2nd edition reprint 2010, Narosa Publishing House
2. Park J.B. and Lakes R.S., Biomaterials: An Introduction, 3rd edition, Springer press , 2007

Reference Books:

1 Park J.B. and Bronzino J.D., Biomaterials: Principals and Applications, CRC Press, 2003
2 Park J.B., Biomaterials Science and Engineering, Springer Press 1984
3 Rattner B.D., Hoffman A.S, Schoen F.J., Lemons J.E., Biomaterials Science: An Introduction to Materials in Medicine, Academic Press 2004

IV Year **I Semester**	**PROJECT WORK (PHASE – I)**	**L**	**P**	**C**
		0	**0**	**2.5**

IV Year I Semester	INTERNSHIP FOLLOWED BY SEMINAR	L	P	C
		0	0	1

IV Year I Semester	MATERIALS JOINING LAB	L	P	C
		0	3	1.5

(**Course objective:**To give hands-on practice on various arc welding practices, to study the microstructure of welds and to write the welding reports)

List of Experiments:

1. Bead-on-plate welding
2. Effect of welding parameters on weld bead
3. GTA welding
4. GMA welding
5. Submerged arc welding
6. Microstructural observation of Ferrousweldments
   - Carbon steel
   - Stainless steel
7. Microstructural observation of Non-Ferrous weldments
   - Aluminiumalloys
   - Titanium alloys
8. Microstructural observation of Dissimilar Joints
9. Hardness survey across the weldment
10. Practice for preparation of welding procedure qualification.

List of Equipment:

1. Multipower welding source capable of SMAW,SAW, GMAW,GTAW. - 1No
2. Individual power sources and accessories for MMAW - 4 Nos.
3. Metallurgical microscopes - - 4 Nos.
4. Micro Hardness Testing Equipment - 1 No

(Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:

I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

II.

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

IV Year I Semester	COMPOSITE MATERIALS LAB	L	P	C
		0	3	1.5

(**Course objective:**To become familiar with the fabrication and various testing methods used for composite materials)

List of Experiments:

1. Fabrication of metal matrix composites by liquid state process.
2.Fabrication of metal matrix composites by solid state process.
3. Fabrication of polymer matrix composites with natural fibers.
4. Fabrication of carbon fiber reinforced PMC.
5. Metallography of metal matrix composite materials
6. Hardness of various composite materials
7. Tensile strength of the various composite materials
8. Flexural Strength of various composite materials
9. Impact strength of various composite materials
10.Ageing Studies of PMCs

List of Equipment:

1. Auto clave
2. Sintering furnace with controlled atmosphere
3. Bottom pouring vacuum stir casting furnace
4. Laboratory pyrolysis unit
5. Impact strength tester
6. Universal Testing machine with tensile and flexural testing accessories
7. Brinell Hardness tester
8. Rockwell hardness tester
9. Metallurgical Microscope

(Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:

I.

1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

II.

At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

IV Year II Semester	INTRODUCTION TO INDUSTRIAL MANAGEMENT	L	P	C
		3	0	3

Course Objectives:

- To impart knowledge on scientific principles of management to improve productivity in manufacturing Industry.
- To impart knowledge on fundamentals of functional management to improve performance in industry.
- To introduce basic tools of operations management
- To teach concepts of personnel management and value engineering
- To provide fundamental principles of project management

Unit – I

Introduction: Definition of Industrial Engineering, Development, Applications, Role of an industrial engineer, Quantitative tools of IE and productivity measurement, Concepts of Management, Importance, Functions of management, Scientific management, Taylor's principles, Douglas McGregor's Theory X andTheory Y, Fayol's principles of management.

Unit-II:

Functional Management: Human Resource management: Concept and functions of Human Resource Management, Concept of HRM and HRD Industrial relations, Job-evaluation and merit rating, wage and salary administration.- Marketing Management: Marketing mix and elements of marketing, strategies.- Financial management: objective and functions of Financial Management.

Unit – III

Operations Management: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs.

Unit – IV

Plant location and layout: Types and principles of plant layouts, Factors affecting plant location and layout, -Statistical Quality Control: Types of control charts, control charts for variables and control charts for attributesand its applications with numerical examples.

Unit – V

Project management: Basics for construction of network diagram,Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) – PERT Vs. CPM, determination of floats, Project crashing and its procedure.

Course Outcomes:

Upon successful completion of this course you should be able to:

- The learner is able to analyses, interpret data and gain knowledge of Industrial Management.
- The knowledge of designing a system, component or process and synthesize solutions to achieve desired needs.
- The learner can use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints through work study.
- The learner can able to know about the application of statistics in quality control and management.The student can know their role as engineers in the present modern society and function effectively within multi-disciplinary teams.
- The learner can understand the fundamental concepts of effective project management design and conduct experiments.

Text Books:

1. Industrial Engineering and Management by O.P Khanna, Khanna Publishers
2. Industrial Engineering and Management by N.V.S. Raju, Cengage Learning

Reference Books:

1. Industrial Engineering and Production Management, Martand Telsang,S.Chand& Company Ltd. New Delhi
2. Operations Management by J.G Monks, Mc Graw Hill Publishers.
3. Production and Operations Management – R.Panneerselvam- PHI- 3rdEdition
4. Principles of Management by Koontz O' Donnel, McGraw Hill Publishers.
5. PERTandCPM by L.S Srinath, East west Press.
6. Production and operations management by K.C Arora.
7. Statistical Quality Control by Gupta.
8. Manufacturing Organization and Management, Harold T. Amrine, John

IV Year II Semester	NANOMATERIALS	L	P	C
		3	0	3

(**Course objective:** The course conveys the basic concepts relevant to nano material properties, synthesis, characterization and applications)

UNIT-I
(Learning Objectives: Tounderstand importance of nano materials and applications of various nano materials)

General Introduction1-D ,2-D, 3-D nano structured materials, applications of Nano materials Synthesis of Nano materials-Top-down approach and Bottom-Up approach,

UNIT-II
(Learning Objectives: To know about the different synthesis processes used for getting nano materials)

Nanoparticle synthesis by Chemical Methods and Mechanical Methods

UNIT-III
(Learning Objectives: To understand the mechanical behaviour of nano materials under various conditions)

Mechanical Behaviour, Anamolos Deformation behavior of nanosturctutredmaterials ,Room temperature creep

UNIT-IV
(Learning Objectives: To know about the electrical and optical phenomena of nano materials)

Electrical Properties: Switching glasses with nanoparticles,Electronic conduction with nanoparticles
Optical Properties: Optical properties, special properties and the coloured glasses

UNIT-V
(Learning Objectives: To know about the various characterization techniques used for seeing nano materials)

Structural characterization: Electron microscopy, scanning probe microscopy for nano science and technology, X-ray diffraction.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's learning abilities should be tested by giving take home assignments. Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books
1. Textbook of nanoscience and nanotechnology, B.S. Murty et al. Universities Press 2012
2. Nano: the essentials- T.Pradeep, Tata McGrawHill Publishers, 2007
Reference Books:
1. Introduction to nanotechnology, Charles P. Poole, Wiley publishers, 2003

IV Year II Semester	FATIGUE AND FRACTURE MECHANICS (PROFESSIONAL ELECTIVE-V)	L	P	C
		3	0	3

(**Course objectives:**To develop the knowledge about the essential mechanical properties of engineering materials such as fatigue and fracture to apply them to design the materials for various load-bearing structural engineering applications.)

UNIT – I

(Learning Objectives: To know basic mechanisms of fatigue behaviour and effect of stress concentration)

Fatigue of structures, S-N curves, Endurance limits, Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentrations, Neuber's stress concentration factors, Plastic stress concentration factors, Notched S.N. curves, Fatigue of composite materials.

UNIT - II

(Learning Objectives: To know about the effect of low cycle and high cycle fatigue on materials)

Statistical aspects of fatigue behavior, low cycle and high cycle fatigue, Coffin-Manson's relation, Transition life, cyclic strain hardening and softening, Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner's theory, Other theories.

UNIT - III

(Learning Objectives: To learn the fatigue fracture phenomenon, crack initiation and growth)

Physical aspects of fatigue Phase in fatigue life, crack initiation, crack growth, final Fracture, Dislocations, fatigue fracture surfaces.

UNIT - IV

(Learning Objectives: To understand fracture mechanics and concept of fracture toughness)

Fracture mechanics, strength of cracked bodies, potential energy and surface energy, Griffith's theory, irwin-orwin extension of Griffith's theory to ductile materials, stress analysis of cracked bodies, effect of thickness on fracture toughness, stress intensity factors for typical geometries.

UNIT - V

*(Learning Objectives: To know how to e*valuate and analyze the *life of material by testing and good design)*

Fatigue design and testing , safe life and Fail-safe design philosophies, Importance of Fracture Mechanics in aerospace structures, application to composite materials and structures.

Assessment: The student should be evaluated based on the assignments and objective tests. The student's analytical abilities (with special focus on academically weak students) should be tested periodically in classes by giving problems). Emphasis should be given by conducting tutorial classes at the end of each unit.)

TEXT BOOKS:

1. Barrois W, Ripely, E.L., “Fatigue of aircraft structure," Pergamon press. Oxford, 1983.
2. Prasanth Kumar, "Elements of fracture mechanics", Wheeter publication, 1999.

REFERENCES:

1. KareHellan, ‘Introduction to Fracture Mechanics’, McGraw Hill, Singapore,1985
2. Knott, J.F., “Fundamentals of Fracture Mechanics,” - Buterworth& Co., Ltd., London, 1983.
3. Sih C.G., “Mechanics of fracture.” Vol - I, Sijthoff and w Noordhoff International Publishing Co., Netherlands, 1989.

IV Year II Semester	ENERGY MATERIALS (PROFESSIONAL ELECTIVE-V)	L	P	C
		3	0	3

(**Course objectives:**To learn the operating principle of several environmentally friendly energy technologies and to identify the material issues relevant to these technologies and to evaluate various operationalaspects associated with these technologies)

UNIT – I
(Learning Objectives: To learn the solar cells phenomenon, different photovoltaic materials)

Solar cell materials: single and polycrystalline Silicon, amorphous silicon, CdSe, CdTe, Copper Indium Gallium Selenide (CIGS), Gallium Arsenide for applications in photovoltaic's , Quantum Dots

UNIT – II
(Learning Objectives: To learn the concept the concept of fuel cell technology, materials usage of materials in batteries)

Basics of electrochemical energy devices: mechanism and materials for different types of batteries, concept of fuel cell technology, super capacitors and hybrid fuel cells (PEM fuel cell, Acid/alkaline fuel cells.)

UNIT – III
(Learning Objectives: To understand usage of materials in energy harvesting)

Materials for energy harvesting: Piezoelectric, Pyroelectric and Thermo-electrics materials, Electrostatic (capacitive) Energy Harvesting materials, electro active polymers (EAPs), energy harvesting using Magnetic Induction.

UNIT – IV
(Learning Objectives: To understand usage of materials in energy storge)

Different types of energy storage and conversion devices: Solar energy conversion devices, Wind & Mechanical Energy storages, Sensible Heat Storage Materials. failure modes and environmental impact of energy materials

UNIT – V
(Learning Objectives: To know about the different synthesis processes used for making energy materials)

Materials Synthesis Methods
Physical Methods: Vacuum Evaporation, Sputtering, Cathodic Arc Deposition, Chemical Vapour Deposition, Lithography
Chemical Methods: Sol-Gel technique, self assembly, colloidal method, hydro-thermal method, Co-precipitation method, solid state synthesis, micro-emulsion method.

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's learning abilities should be tested by conducting concept tests. Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Book:

1. Advanced Energy Materials, Ashutosh Tiwari & Sergiy Valyukh, J. Wiley & Sons
2. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press.

Reference Books:

1. Materials Science in Energy Technology 1st Edition by G Libowitz.
2. Energy Storage & Conversion: Materials & Devices by A. Kumar, S. K. Das.

IV Year II Semester	CERAMIC SCIENCE AND TECHNOLOGY (PROFESSIONAL ELECTIVE-V)	L	P	C
		3	0	3

(**Course objective:** This course is intended to provide in depth knowledge on processing ceramicmaterials including structure, properties, phase transformations, applications, and fabrication methodsof ceramics.)

UNIT – I
(Learning Objectives: To know the structure and properties of ceramic materials)

Introduction and Crystal structures: Definition, Classification of Ceramics, Traditional Ceramics, Structural Ceramics, Ceramic super conductors. Crystal structures in Ceramics, Grouping of ions and Pouling's rules, Oxide structures, Silicate structures, Glass formation, Models of glass structure Types of glasses.

UNIT – II
(Learning Objectives: To know phase diagrams and comprehend the phase transformations in ceramic materials *)*

Equilibrium Diagrams of ceramic systems: Two component systems like Al_2O_3 – SiO_2 and BaO – $TiO_2$and Three component systems MgO – Al_2O_3 – SiO_2

UNIT – III
(Learning Objectives: To know about various processing techniques used for making ceramic materials)

Powder Preparation Techniques: Sol-gel technology – Precipitation, Co-precipitation and Hydrothermal precipitation techniques. Preparation of Al2O3, ZrO2, SiC, Si3N4 BN & B4C.

UNIT – IV
(Learning Objectives: To Learn about various ceramic processing methods)

Ceramic Processing Techniques:Injection moulding, Slip casting, Tape casting, Gel casting, ExtrusionSintering, Hot Pressing, Hot Isostatic Pressing, (HIP), Spark Plasma Sintering .

UNIT – V
(Learning Objectives: To Understand and design the electrical, magnetic and optical properties of ceramic systems)

Microstructure, mechanical, Thermal, electrical, optical, magnetic, and chemical properties of ceramic materials

(Assessment: The student should be evaluated based on the assignments and objective tests. The student's learning abilities should be tested by conducting concept tests. Emphasis should be given by conducting tutorial classes at the end of each unit.)

Text Books:

1. Introduction to Ceramics, W.D. Kingery et al, John Wiley
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

Reference Books:

1. FINCER proceedings of workshop on fine ceramics synthesis, properties and applications, T.R. Rammohan et al.
2. Hand Book of Fibre, reinforced composite materials, Ed. Lubin.
3. Fundamentals of Ceramics, M W Barsoum
4. Ceramics, Mechanical Properties, Failure Behaviour, Material Selection, D. Munz& T. Fett
5. Ceramic Science and Technology, Vol. 2 Material Selection and Properties Ed., Ralf Riedel and I, Wei Chen, Wiely, VCH

IV Year II Semester	Nano Materials Lab	L	P	C
		0	2	1

(Curse objective: The course is intended to cover basic preparation methods and characterization of nanomaterials.**)**

List of Experiments:

1. Reduction of the Bulk material to Nanomaterial by using Planetary Ball-Milland particle size distribution estimation

2. Synthesis of nanoparticles by appropriate techniques (precipitation, sol-gel,microemulsion, solvothermal,etc).

3. Vapor depositiontechniques for thin film deposition

4. Phase analysis of binary mixture by X-ray Diffraction

5. Determination of Residual Strain in nano structured materials by using XRD

6. Determination of microstrain by using X-Ray diffractionAnalysis.

7.Determination of average crystallite size by using X-Ray diffraction Analysis.
8. Microstructural analysis of metal and oxide samples using FESEM
9. Micro Chemical Analysis of nano particles.
10. Surface area and pore volume measurements of nanoparticles.

List of Equipment:
1. Planetary Ball-Mill
2. Sol-gel equipment
3. Vapor deposition equipment
4. XRD unit
5. FESEM – EDS

(Assessment: The student's performance should be evaluated at the end of each class based on the following parameters:
I.
1. *observation book,*
2. *Record.*
3. *Conduct of the experiment successfully*
4. *Interpretation of the data*
5. *Drawing the graphs where ever necessary*
6. *Viva-voce.*

II.
At the end of each cycle of experiments internal exams should be conducted in addition to the end examination)

IV Year **II Semester**	**Project Work (Phase - II)**	**L**	**P**	**C**
		0	**0**	**8**