## SEMESTER II

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**Electrical Circuits Laboratory**  
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**Circuits and Devices Laboratory**  
(For branches under I & C Faculty)

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+ Offering English Language Laboratory as an additional subject (with no marks) during 2nd semester may be decided by the respective Colleges affiliated to Anna University Chennai.

**A. CIRCUIT BRANCHES**

**I Faculty of Electrical Engineering**

1. B.E. Electrical and Electronics Engineering
2. B.E. Electronics and Instrumentation Engineering
3. B.E. Instrumentation and Control Engineering

**II Faculty of Information and Communication Engineering**

1. B.E. Computer Science and Engineering
2. B.E. Electronics and Communication Engineering
3. B.E. Bio Medical Engineering
4. B.Tech. Information Technology

**B. NON – CIRCUIT BRANCHES**

**I Faculty of Civil Engineering**

1. B.E. Civil Engineering

**II Faculty of Mechanical Engineering**

1. B.E. Aeronautical Engineering
2. B.E. Automobile Engineering
3. B.E. Marine Engineering
4. B.E. Mechanical Engineering
5. B.E. Production Engineering
### III Faculty of Technology

1. B.Tech. Chemical Engineering  
2. B.Tech. Biotechnology  
3. B.Tech. Polymer Technology  
4. B.Tech. Textile Technology  
5. B.Tech. Textile Technology (Fashion Technology)  

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*Four weeks industrial training during sixth semester holidays*
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## LIST OF ELECTIVES FOR B.E MATERIALS SCIENCE AND ENGINEERING

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HS2161  TECHNICAL ENGLISH II  

L T P C  3 1 0 4

AIM:
To encourage students to actively involve in participative learning of English and to help them acquire Communication Skills.

OBJECTIVES:
- To help students develop listening skills for academic and professional purposes.
- To help students acquire the ability to speak effectively in English in real-life situations.
- To inculcate reading habit and to develop effective reading skills.
- To help students improve their active and passive vocabulary.
- To familiarize students with different rhetorical functions of scientific English.
- To enable students write letters and reports effectively in formal and business situations.

UNIT I
Technical Vocabulary – meanings in context, sequencing words, Articles– Prepositions, intensive reading& predicting content, Reading and interpretation, extended definitions, Process description

Suggested activities:
1. Exercises on word formation using the prefix ‘self’ - Gap filling with preposition.
2. Exercises - Using sequence words.
3. Reading comprehension exercise with questions based on inference – Reading headings
4. and predicting the content – Reading advertisements and interpretation.
5. Writing extended definitions – Writing descriptions of processes – Writing paragraphs based on discussions – Writing paragraphs describing the future.
UNIT II  

Suggested activities:
1. Reading comprehension exercises with questions on overall content – Discussions analyzing stylistic features (creative and factual description) - Reading comprehension exercises with texts including graphic communication - Exercises in interpreting non-verbal communication.
2. Listening comprehension exercises to categorise data in tables.
3. Writing formal letters, quotations, clarification, complaint – Letter seeking permission for Industrial visits – Writing analytical paragraphs on different debatable issues.

UNIT III  
Cause and effect expressions – Different grammatical forms of the same word - Speaking – stress and intonation, Group Discussions - Reading – Critical reading - Listening, - Writing – using connectives, report writing – types, structure, data collection, content, form, recommendations .

Suggested activities:
1. Exercises combining sentences using cause and effect expressions – Gap filling exercises using the appropriate tense forms – Making sentences using different grammatical forms of the same word. ( Eg: object – verb / object – noun )
2. Speaking exercises involving the use of stress and intonation – Group discussions – analysis of problems and offering solutions.
3. Reading comprehension exercises with critical questions, Multiple choice question.

UNIT IV  
Numerical adjectives – Oral instructions – Descriptive writing – Argumentative paragraphs – Letter of application - content, format (CV / Bio-data) - Instructions, imperative forms - Checklists, Yes/No question form – E-mail communication.

Suggested Activities:
1. Rewriting exercises using numerical adjectives.
2. Reading comprehension exercises with analytical questions on content – Evaluation of content.
3. Listening comprehension – entering information in tabular form, intensive listening exercise and completing the steps of a process.
4. Speaking - Role play – group discussions – Activities giving oral instructions.

UNIT V  
Speaking - Discussion of Problems and solutions - Creative and critical thinking – Writing an essay, Writing a proposal.

Suggested Activities:
1. Case Studies on problems and solutions
2. Brain storming and discussion
3. Writing Critical essays
4. Writing short proposals of 2 pages for starting a project, solving problems, etc.
5. Writing advertisements.

TOTAL: 60 PERIODS

TEXT BOOK:

REFERENCES:

EXTENSIVE READING:

NOTE:
The book listed under Extensive Reading is meant for inculcating the reading habit of the students. They need not be used for testing purposes.

MA2161 MATHEMATICS – II

UNIT I ORDINARY DIFFERENTIAL EQUATIONS
Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy’s and Legendre’s linear equations – Simultaneous first order linear equations with constant coefficients.

UNIT II VECTOR CALCULUS

UNIT III ANALYTIC FUNCTIONS
Functions of a complex variable – Analytic functions – Necessary conditions, Cauchy – Riemann equation and Sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping : w= z+c, cz, 1/z, and bilinear transformation.

UNIT IV COMPLEX INTEGRATION
Complex integration – Statement and applications of Cauchy’s integral theorem and Cauchy’s integral formula – Taylor and Laurent expansions – Singular points – Residues
– Residue theorem – Application of residue theorem to evaluate real integrals – Unit circle and semi-circular contour (excluding poles on boundaries).

**UNIT V LAPLACE TRANSFORM**


Definition of Inverse Laplace transform as contour integral – Convolution theorem (excluding proof) – Initial and Final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

**TOTAL: 60 PERIODS**

**TEXT BOOKS:**


**REFERENCES:**


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**PH2161 ENGINEERING PHYSICS – II**

**UNIT I CONDUCTING MATERIALS**


**UNIT II SEMICONDUCTING MATERIALS**


**UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS**


Superconductivity : properties - Types of super conductors – BCS theory of superconductivity(Qualitative) - High Tc superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation.

UNIT IV DIELECTRIC MATERIALS 9

UNIT V MODERN ENGINEERING MATERIALS 9
Metallic glasses: preparation, properties and applications.
Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application, advantages and disadvantages of SMA

TOTAL: 45 PERIODS

TEXT BOOKS:
2. Charles P. Poole and Frank J.Ownen, ‘Introduction to Nanotechnology’, Wiley India(2007) (for Unit V)

REFERENCES:

CY2161 ENGINEERING CHEMISTRY – II L T P C
3 0 0 3

AIM
To impart a sound knowledge on the principles of chemistry involving the different application oriented topics required for all engineering branches.

OBJECTIVES
• The student should be conversant with the principles electrochemistry, electrochemical cells, emf and applications of emf measurements.
• Principles of corrosion control
• Chemistry of Fuels and combustion
• Industrial importance of Phase rule and alloys
• Analytical techniques and their importance.
UNIT I  ELECTROCHEMISTRY  9
Electrochemical cells – reversible and irreversible cells – EMF – measurement of emf –
Single electrode potential – Nernst equation (problem) – reference electrodes – Standard
Hydrogen electrode - Calomel electrode – Ion selective electrode – glass electrode and
measurement of pH – electrochemical series – significance – potentiometer titrations
(redox - Fe²⁺ vs dichromate and precipitation – Ag⁺ vs CI⁻ titrations) and conduct metric
titrations (acid-base – HCl vs, NaOH) titrations,

UNIT II  CORROSION AND CORROSION CONTROL  9
Chemical corrosion – Pilling – Bedworth rule – electrochemical corrosion – different
types – galvanic corrosion – differential aeration corrosion – factors influencing corrosion
– corrosion control – sacrificial anode and impressed cathodic current methods –
corrosion inhibitors – protective coatings – paints – constituents and functions – metallic
coatings – electroplating (Au) and electroless (Ni) plating.

UNIT III  FUELS AND COMBUSTION  9
Calorific value – classification – Coal – proximate and ultimate analysis metallurgical
coke – manufacture by Otto-Hoffmann method – Petroleum processing and fractions –
cracking – catalytic cracking and methods-knocking – octane number and cetane
number – synthetic petrol – Fischer Tropsch and Bergius processes – Gaseous fuels-
water gas, producer gas, CNG and LPG, Flue gas analysis – Orsat apparatus –
theoretical air for combustion.

UNIT IV  PHASE RULE AND ALLOYS  9
Statement and explanation of terms involved – one component system – water system –
condensed phase rule – construction of phase diagram by thermal analysis – simple
eutectic systems (lead-silver system only) – alloys – importance, ferrous alloys –
nichrome and stainless steel – heat treatment of steel, non-ferrous alloys – brass and
bronze.

UNIT V  ANALYTICAL TECHNIQUES  9
Beer-Lambert’s law (problem) – UV-visible spectroscopy and IR spectroscopy –
principles – instrumentation (problem) (block diagram only) – estimation of iron by
colorimetry – flame photometry – principle – instrumentation (block diagram only) –
estimation of sodium by flame photometry – atomic absorption spectroscopy – principles
– instrumentation (block diagram only) – estimation of nickel by atomic absorption
spectroscopy.

TOTAL: 45 PERIODS

TEXT BOOKS:
Delhi (2002).

REFERENCES:
(2008).
OBJECTIVE
At the end of this course the student should be able to understand the vectorial and scalar representation of forces and moments, static equilibrium of particles and rigid bodies both in two dimensions and also in three dimensions. Further, he should understand the principle of work and energy. He should be able to comprehend the effect of friction on equilibrium. He should be able to understand the laws of motion, the kinematics of motion and the interrelationship. He should also be able to write the dynamic equilibrium equation. All these should be achieved both conceptually and through solved examples.

UNIT I  
BASICS & STATIC OF PARTICLES  

UNIT II  
EQUILIBRIUM OF RIGID BODIES  

UNIT III  
PROPERTIES OF SURFACES AND SOLIDS  

UNIT IV  
DYNAMICS OF PARTICLES  

UNIT V  
FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS  

TOTAL: 60 PERIODS

TEXT BOOK:
REFERENCES:

EE2151 CIRCUIT THEORY
(Common to EEE, EIE and ICE Branches)

UNIT I BASIC CIRCUITS ANALYSIS

UNIT II NETWORK REDUCTION AND NETWORK THEOREMS FOR DC AND AC CIRCUITS:
Network reduction: voltage and current division, source transformation – star delta conversion.
Thevenins and Novton & Theorem – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem.

UNIT III RESONANCE AND COUPLED CIRCUITS

UNIT IV TRANSIENT RESPONSE FOR DC CIRCUITS
Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. with sinusoidal input.

UNIT V ANALYSING THREE PHASE CIRCUITS
Three phase balanced / unbalanced voltage sources – analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & un balanced – phasor diagram of voltages and currents – power and power factor measurements in three phase circuits.

TOTAL: 60 PERIODS

TEXT BOOKS:
REFERENCES:

EC2151 ELECTRIC CIRCUITS AND ELECTRON DEVICES L T P C
(For ECE, CSE, IT and Biomedical Engg. Branches) 3 1 0 4

UNIT I CIRCUIT ANALYSIS TECHNIQUES 12

UNIT II TRANSIENT RESONANCE IN RLC CIRCUITS 12

UNIT III SEMICONDUCTOR DIODES 12

UNIT IV TRANSISTORS 12
Principle of operation of PNP and NPN transistors – study of CE, CB and CC configurations and comparison of their characteristics – Breakdown in transistors – operation and comparison of N-Channel and P-Channel JFET – drain current equation – MOSFET – Enhancement and depletion types – structure and operation – comparison of BJT with MOSFET – thermal effect on MOSFET.

UNIT V SPECIAL SEMICONDUCTOR DEVICES (Qualitative Treatment only) 12

TOTAL: 60 PERIODS

TEXT BOOKS:
REFERENCES:

GE2151    BASIC ELECTRICAL AND ELECTRONICS ENGINEERING        L  T  P  C
(Common to branches under Civil, Mechanical and Technology faculty)   4 0 0 4

UNIT I    ELECTRICAL CIRCUITS & MEASUREMENTS                     12

Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters.

UNIT II    ELECTRICAL MECHANICS                                    12

UNIT III   SEMICONDUCTOR DEVICES AND APPLICATIONS                   12


UNIT IV    DIGITAL ELECTRONICS                                      12
Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders – Flip-Flops – Registers and Counters – A/D and D/A Conversion (single concepts)

UNIT V     FUNDAMENTALS OF COMMUNICATION ENGINEERING                12

Communication Systems: Radio, TV, Fax, Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

TOTAL: 60 PERIODS

TEXT BOOKS:
REFERENCES:

GE2152  BASIC CIVIL & MECHANICAL ENGINEERING  L  T  P  C
(Common to branches under Electrical and I & C Faculty)  4 0 0 4

A – CIVIL ENGINEERING

UNIT I  SURVEYING AND CIVIL ENGINEERING MATERIALS  15


UNIT II  BUILDING COMPONENTS AND STRUCTURES  15

Foundations: Types, Bearing capacity – Requirement of good foundations.


TOTAL: 30 PERIODS

B – MECHANICAL ENGINEERING

UNIT III  POWER PLANT ENGINEERING  10

UNIT IV  IC ENGINES  10
Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines – Boiler as a power plant.
UNIT V  REFRIGERATION AND AIR CONDITIONING SYSTEM  10
Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and
absorption system – Layout of typical domestic refrigerator – Window and Split type
room Air conditioner.

REFERENCES:
1. Shanmugam G and Palanichamy M S, “Basic Civil and Mechanical
   (1999).
5. Shantha Kumar S R J., “Basic Mechanical Engineering”, Hi-tech Publications,

GE2155  COMPUTER PRACTICE LABORATORY – II  L T P C
0 1 2  2

LIST OF EXPERIMENTS
1. UNIX COMMANDS  15
   Study of Unix OS - Basic Shell Commands - Unix Editor

2. SHELL PROGRAMMING  15
   Simple Shell program - Conditional Statements - Testing and Loops

3. C PROGRAMMING ON UNIX  15
   Dynamic Storage Allocation-Pointers-Functions-File Handling

TOTAL: 45 PERIODS

HARDWARE / SOFTWARE REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Hardware
☐ 1 UNIX Clone Server
☐ 33 Nodes (thin client or PCs)
☐ Printer – 3 Nos.

Software
☐ OS – UNIX Clone (33 user license or License free Linux)
☐ Compiler - C
LIST OF EXPERIMENTS

1. Determination of Young's modulus of the material – non uniform bending.
2. Determination of Band Gap of a semiconductor material.
3. Determination of specific resistance of a given coil of wire – Carey Foster Bridge.
5. Spectrometer dispersive power of a prism.
6. Determination of Young’s modulus of the material – uniform bending.

• A minimum of FIVE experiments shall be offered.
• Laboratory classes on alternate weeks for Physics and Chemistry.
• The lab examinations will be held only in the second semester.

LIST OF EXPERIMENTS

1. Conduct metric titration (Simple acid base)
2. Conduct metric titration (Mixture of weak and strong acids)
3. Conduct metric titration using BaCl$_2$ vs Na$_2$SO$_4$
4. Potentiometric Titration (Fe$^{2+}$/KMnO$_4$ or K$_2$Cr$_2$O$_7$)
5. PH titration (acid & base)
6. Determination of water of crystallization of a crystalline salt (Copper sulphate)
7. Estimation of Ferric iron by spectrophotometry.

• A minimum of FIVE experiments shall be offered.
• Laboratory classes on alternate weeks for Physics and Chemistry.
• The lab examinations will be held only in the second semester.
List of Exercises using software capable of Drafting and Modeling

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.
2. Drawing of a Title Block with necessary text and projection symbol.
3. Drawing of curves like parabola, spiral, involute using Bspline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views (eg. V-block, Base of a mixie, Simple stool, Objects with hole and curves).
6. Drawing of a plan of residential building ( Two bed rooms, kitchen, hall, etc.)
7. Drawing of a simple steel truss.
8. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
10. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.

Note: Plotting of drawings must be made for each exercise and attached to the records written by students.

List of Equipments for a batch of 30 students:

1. Pentium IV computer or better hardware, with suitable graphics facility -30 No.
2. Licensed software for Drafting and Modeling. – 30 Licenses
3. Laser Printer or Plotter to print / plot drawings – 2 No.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

1. Verification of ohm’s laws and kirchoff’s laws.
2. Verification of Thevemin’s and Norton’s Theorem
3. Verification of superposition Theorem
4. Verification of maximum power transfer theorem.
5. Verification of reciprocity theorem
6. Measurement of self inductance of a coil
7. Verification of mesh and nodal analysis.
8. Transient response of RL and RC circuits for DC input.
10. Frequency response of single tuned coupled circuits.

TOTAL: 45 PERIODS
1. Verification of KVL and KCL
2. Verification of Thevenin and Norton Theorems.
3. Verification of superposition Theorem.
4. Verification of Maximum power transfer and reciprocity theorems.
5. Frequency response of series and parallel resonance circuits.
6. Characteristics of PN and Zener diode
7. Characteristics of CE configuration
8. Characteristics of CB configuration
9. Characteristics of UJT and SCR
10. Characteristics of JFET and MOSFET

TOTAL: 45 PERIODS

ENGLISH LANGUAGE LABORATORY (Optional)

1. Listening:
   Listening & answering questions – gap filling – Listening and Note taking- Listening to telephone conversations

2. Speaking:
   Pronouncing words & sentences correctly – word stress – Conversation practice.

Classroom Session
1. Speaking: Introducing oneself, Introducing others, Role play, Debate-
   Presentations: Body language, gestures, postures.
   Group Discussions etc
2. Goal setting – interviews – stress time management – situational reasons

Evaluation
(1) Lab Session – 40 marks
   Listening – 10 marks
   Speaking – 10 marks
   Reading – 10 marks
   Writing – 10 marks

(2) Classroom Session – 60 marks
   Role play activities giving real life context – 30 marks
Note on Evaluation
1. Examples for role play situations:
   a. Marketing engineer convincing a customer to buy his product.
   b. Telephone conversation – Fixing an official appointment / Enquiry on availability of flight or train tickets / placing an order, etc.
2. Presentations could be just a Minute (JAM activity) or an Extempore on simple topics or visuals could be provided and students could be asked to talk about it.

REFERENCES:

LAB REQUIREMENTS
1. Teacher – Console and systems for students
2. English Language Lab Software
3. Tape Recorders.

MA2211 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATION L T P C
(Collect to all branches) 3 1 0 4

OBJECTIVES
The course objective is to develop the skills of the students in the areas of Transforms and Partial Differential Equations. This will be necessary for their effective studies in a large number of engineering subjects like heat conduction, communication systems, electro-optics and electromagnetic theory. The course will also serve as a prerequisite for post graduate and specialized studies and research.

UNIT I FOURIER SERIES 9 + 3

UNIT II FOURIER TRANSFORMS 9 + 3
UNIT III  PARTIAL DIFFERENTIAL EQUATIONS  9 + 3
Formation of partial differential equations – Lagrange’s linear equation – Solutions of standard types of first order partial differential equations - Linear partial differential equations of second and higher order with constant coefficients.

UNIT IV  APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS  9 + 3
Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction (Insulated edges excluded) – Fourier series solutions in cartesian coordinates.

UNIT V  Z-TRANSFORMS AND DIFFERENCE EQUATIONS  9 + 3

LECTURES: 45  TUTORIALS : 15  TOTAL : 60 PERIODS

TEXT BOOKS

REFERENCES

ML3202  FOUNDRY AND MACHINING PROCESSES  LT P C
3 0 0 3

OBJECTIVE
Foundry and machining, which are important processes to give shape to components, are introduced to students. The students are exposed to various stages of foundry and machining operations

UNIT I  PATTERN PREPARATION AND MOULDING  9
Introduction to foundry operations, patterns – functions, types, allowances, selection of pattern materials, colour codes, core boxes, moulding practice, ingredients of moulding sand and core sand, Testing of moulding sands, sand preparation, Sand moulding green sand moulding, dry sand moulding, skin dry sand moulding, core sand moulding, loam moulding, fluid sand process, shell moulding, pit and floor moulding, carbon-oxide process.

UNIT II  MELTING PRACTICE AND CASTING TECHNIQUES  9
Melting practice and special precautions for steels, alloy steels, cast irons, aluminum alloys, copper alloys and magnesium alloys, safety considerations, fluxing degassing and inoculation. Sand casting, permanent mould casting, die casting, centrifugal
casting, plaster mould casting, investment casting, continuous casting, squeeze casting, full mould process.

**UNIT III  FUNDAMENTALS OF CUTTING**


**UNIT IV  TURNING, DRILLING AND RELATED PROCESSES**


**UNIT V  MILLING, SHAPING AND RELATED PROCESSES**

Milling operations – Milling machines – Planning and shaping – Broaching and broaching machines – Sawing – Filling and finishing – Gear manufactured by machining.

**TOTAL : 45 PERIODS**

**TEXT BOOKS**


**REFERENCES**

OBJECTIVE
The knowledge of thermodynamics is the basic requirement for understanding various alloy systems, phase transformations and interpreting properties. It also covers kinetics of reactions as well as heat and mass transfer in different systems.

UNIT I
INTRODUCTION TO THERMODYNAMICS
Definition of thermodynamic terms; concept of states, systems, equilibrium. Equation of states, extensive and intensive properties, homogeneous and heterogeneous systems. Phase diagram of a single component system. Internal energy, heat capacity, enthalpy, isothermal, and adiabatic processes.

UNIT II
LAWS OF THERMODYNAMICS
The Second law of thermodynamics, entropy degree of reversibility and irreversibility, criteria of equilibrium, auxiliary functions, combined statements, Maxwell's relations, transformation formula, Gibbs-Helmoltz equation. Concept of Third law, temperature dependence of entropy, statistical interpretation of entropy, Deby and Einstein concept of heat capacity, relation between Cp and Cv, Consequences of third law.

UNIT III
THERMODYNAMICS OF REACTIONS

UNIT IV
INTRODUCTION TO METALLURGICAL KINETICS
Heterogeneous reaction kinetics-gas-solid, solid-liquid, liquid-liquid and solid-solid systems. Solid state diffusion- Ficks law, mechanism of diffusion, uphill diffusion, kirkendall effect, steady an transient diffusion, external mass transfer – fluid flow and its relevance to mass transfer, general mass transport equation, concept of mass transfer coefficient, models of mass transfer- film theory and Higbie’s penetration theory, Internal mass transfer- ordinary and Knudsen diffusion, mass transfer with reaction, adsorption-physical adsorption vs. chemisorption.

UNIT V
ELETROCHEMICAL KINETICS
Concept of polarization, activation over potential, Butler-Volmer and Tafel’s equation, applications in Electrodeposition and corrosion, concentration over potential, limiting current, electro-winning and corrosion

TOTAL : 60 PERIODS

TEXTBOOKS
REFERENCES

CE3205  STRENGTH AND TESTING OF MATERIALS  L T P C 3 1 0 4

OBJECTIVES
The students are introduced to various methods of analysis and evaluation of mechanical properties in terms of stress, strain and deformation in different loading modes: tension, compression, shear and torsion. This knowledge is essential for understanding mechanical behaviour of materials. Testing of materials for determination of properties is dealt with in detail.

UNIT I  STRESS STRAIN AND DEFORMATION OF SOLIDS  9
Rigid and deformable bodies – Strength, Stiffness and Stability – stresses; tensile, compressive and shear – deformation of simple and compound bars under axial load – thermal stress – elastic constants – strain energy and unit strain energy – Strain energy in uniaxial loads.

UNIT II  BEAMS - LOADS AND STRESSES  9
Types of beams: supports and loads – shear force and bending moment in beams – cantilever, simply supported and overhanging beams – stresses in beams – theory of simple bending – stress variation along the length and in the beam section.

UNIT III  TENSILE TESTING  10
Engineering stress and engineering strain curve, true stress and true strain curve, instability in tension, effect of strain rate and temperature on flow properties, tensile specimens and testing machines. Notch tensile test, anisotropy of tensile properties.
UNIT IV HARDNESS TESTING AND IMPACT TESTING 9
Brinell, Vickers, Rockwell, Rockwell superficial, rebound, micro hardness tests and testing machines. hardness conversion. Impact, IZOD, Charpy, Instrumented Impact, relation to $K_{IC}$

UNIT V TORSION AND TORSION TESTING 8
Analysis of torsion of circular bars – Shear stress distribution – Bars of solid and hollow circular section – Stepped shaft – Twist and torsion stiffness – Compound shafts – Fixed and simply supported shafts – Application to close-coiled helical springs – Maximum shear stress in spring section including Wahl Factor – Deflection of helical coil springs under axial loads – Design of helical coil springs – stresses in helical coil springs under torsion loads

L : 45, T : 15 , TOTAL : 60 PERIODS

TEXT BOOKS:

REFERENCES:

ML3205 MATERIALS STRUCTURE AND PROPERTIES L T P C
3 0 0 3

OBJECTIVE
The subject introduces the correlation of properties of materials and their structure. It revises student’s knowledge of crystal structure and phase diagrams of various alloy systems. The course not only covers metals, mainly ferrous and non-ferrous alloys, but also structures and properties of ceramics, polymers and composites.

UNIT I STRUCTURE OF MATERIALS 8

UNIT II STRUCTURE OF METALS AND ALLOYS 8
Imperfection in crystals – Point defects – Dislocations – Slip plane – Movement of dislocations – Planar defects and grain boundaries – solid solutions – Hume Rothery

**UNIT III FERROUS AND NON FERROUS ALLOYS**


**UNIT IV CERAMIC AND COMPOSITE MATERIALS**


**UNIT V POLYMER MATERIALS**


**TOTAL : 45 PERIODS**

**TEXT BOOKS**


**REFERENCES**

OBJECTIVE

- To provide knowledge on various Metrological equipments available to measure the dimension of the components.
- To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.

UNIT I  BASICS OF METROLOGY  5

UNIT II  LINEAR AND ANGULAR MEASUREMENTS  10

UNIT III  ADVANCES IN METROLOGY  12

UNIT IV  FORM MEASUREMENT  10
Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications.

UNIT V  MEASUREMENT OF POWER, FLOW AND TEMPERATURE  8

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
CE3207  STRENGTH OF MATERIALS LABORATORY

OBJECTIVE:
To study the properties of materials when subjected to different types of Loading.

1. Tension test on mild steel rod
2. Double shear test on metals
3. Torsion test on mild steel rod.
4. Impact test on metal specimen
5. Hardness test on metals
6. Compression test on helical spring
7. Deflection test on carriage spring

TOTAL : 45 PERIODS

ML3208  MICROSTRUCTURE ANALYSIS LABORATORY

OBJECTIVE
The students having studied phase diagrams and microstructure evolution of various alloy system, experience the manifestation in samples studied by the metallographic technique. This lab is designed to expose students to specimen preparation and microstructure analysis of various commonly used metals and alloys.

List of Experiments
1. Specimen preparation for metallographic observation - working of metallurgical microscope.
2. Grain size measurements.
3. Macro etching - cast, forged and welded components.
4. Sulphur printing and phosphor printing.
5. Microstructure cast iron-gray, nodular and malleable iron - unetched.
7. Microstructure of iron, steel (low carbon, medium carbon, high carbon, hypo and hypereutectoid steels).
8. Microstructure of stainless steels and high speed steels.
9. Over heated structure and banded structure in steels.
10. Microstructure of copper alloys
11. Microstructure of aluminium alloys
12. Microstructure of lead alloys

TOTAL: 45 PERIODS
OBJECTIVE
The students having studied the basics of material structures and properties and strength of materials, shall be introduced to dislocation theories of plasticity behaviour, various strengthening mechanisms and fracture mechanics. It will expose students to failure mechanisms due to fatigue and creep as well as their testing methods.

UNIT I ELASTIC AND PLASTIC BEHAVIOUR 10

UNIT II STRENGTHENING MECHANISMS 10
Elementary discussion of cold working, grain size strengthening. Solid solution strengthening, martensitic strengthening, precipitation strengthening, dispersion strengthening, fibre strengthening, examples of above strengthening mechanisms from ferrous and non-ferrous systems, simple problems. Yield point phenomenon, strain aging and dynamic strain aging

UNIT III FRACTURE AND FRACTURE MECHANICS 9
Types of fracture, basic mechanism of ductile and brittle fracture, Griffith’s theory of brittle fracture, Orowan’s modification. Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, determination of DBTT. Fracture mechanics-introduction, modes of fracture, stress intensity factor, strain energy release rate, fracture toughness and determination of $K_{IC}$, introduction to COD, J integral.

UNIT IV FATIGUE BEHAVIOUR AND TESTING 8
Fatigue: Stress cycles, S-N curves, effect of mean stress, factors affecting fatigue, structural changes accompanying fatigue, cumulative damage, HCF / LCF, thermomechanical fatigue, application of fracture mechanics to fatigue crack propagation, fatigue testing machines.

UNIT V CREEP BEHAVIOUR AND TESTING 9
Creep curve, stages in creep curve and explanation, structural changes during creep, creep mechanisms, metallurgical factors affecting creep, high temperature alloys, stress rupture testing, creep testing machines, parametric methods of extrapolation. Deformation Mechanism Maps according to Frost/Ashby.

L : 45, T : 15, TOTAL : 60 PERIODS

TEXT BOOKS

REFERENCES

ML3210 PRIMARY PROCESSING OF IRON AND STEEL LT P C 3 0 0 3

OBJECTIVE
The course covers the production of iron and steel from raw material, primary processing to refinement to special steels.

UNIT I RAW MATERIALS AND BURDEN PREPARATION 8

UNIT II BLAST FURNACE OPERATION AND REACTIONS 10
Blast furnace parts, construction and design aspects, ancillary equipment for charging, preheating the blast, gas cleaning, pig casting, blast furnace instrumentation and control of furnace. Blast furnace operation, irregularities and remedies. Compositional control of metal and slag in blast furnace, modern trends in blast furnace practice. Reduction of iron ores and oxides of iron by solid and gaseous reductions-thermodynamics and kinetics study of direct and indirect reduction, Gruner’s theorem, blast furnace reactions. C-O and Fe-C-O equilibria, Rist diagrams, material and heat balance.

UNIT III PRINCIPLES OF STEEL MAKING 9
Development of steel making processes, physico-chemical principles and kinetic aspects of steel making, carbon boil, oxygen transport mechanism, desulphurisation, dephosphorisation, slag-functions, composition, properties and theories, raw materials for steel making and plant layout.

UNIT IV BESSEMER, OPEN HEARTH AND OXYGEN STEEL MAKING PROCESSES 9

UNIT V CAST IRON, LADLE METALLURGY AND ELECTRIC STEEL MAKING 9
Arc and Induction furnace-constructional features. Production practice for plain carbon steels, low alloy – Cast irons and ductile iron, stainless, tool and special steels, modern developments. Secondary steel making processes, continuous steel making processes – Deoxidation and teeming practice. Principle, methods and their comparison, killed, rimmed and capped steels, degassing practices, ingot production, ingot defects and
remedies, continuous casting. Indian steel industry and global trends in steel making technology.

**TEXT BOOKS**

**REFERENCES**

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**ML3211**
**NONFERROUS METALLURGY**
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**OBJECTIVES:**
To understand the structure, property relations of non-ferrous alloys with special emphasis on engineering applications.

**UNIT I COPPER ALLOYS**
Properties and applications of metallic copper: Major alloys of Copper: Brasses, Cu-Zn alloys, Phase diagram of industrially relevant portion, different compositions, characteristics and uses. Bronzes, Tin bronze, compositions, properties and uses, other bronzes like Cu-Al. Cu-Si. Cu-Mn and Cu-Be alloying systems. Their special properties and applications, Cu-Ni alloys. Cu-Cr alloys.

**UNIT II ALUMINIUM AND ITS ALLOYS**

**UNIT III MAGNESIUM AND TITANIUM ALLOYS**
Magnesium - properties and uses of Magnesium alloys. Titanium -Unique characteristics of the metal – α, α-β and β Titanium alloys - major types, Titanium aluminides their properties and uses.

**UNIT IV NICKEL AND ZINC ALLOYS**
Properties of nickel and uses of nickel, alloys of nickel, nickel in special alloys and magnetic materials, Nickel aluminides, Use of zinc in corrosion protection of ferrous materials, Zinc alloys, properties and uses, Die, casting qualities.
UNIT V LEAD, TIN, ANTIMONY AND PRECIOUS METALS

Major characteristics and applications, low melting nature and solder alloys. Gold, Silver and Platinum, Nobility of these metals, Engineering properties and applications of these metals and their alloys.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES

ML3212 POWDER METALLURGY

OBJECTIVE
This course teaches powder preparation, characterization, compaction and sintering. This knowledge is essential to understand powder metallurgy applications in aerospace, automobile and machining materials.

UNIT I CHARACTERISTICS AND TESTING OF METAL POWDERS
Sampling, chemical composition purity, surface contamination etc. Particle size and its measurement, Principle and procedure of sieve analysis, microscopic analysis: sedimentation, elutriation, permeability. adsorption methods and resistivity methods: particle shape, classifications, microstructure, specific surface area. apparent and tap density. green density. green strength, sintered compact density, porosity, shrinkage.

UNIT II POWDER MANUFACTURE AND CONDITIONING
Mechanical methods Machine milling, ball milling, atomization, shotting. chemical methods, condensation, thermal decomposition, carbonyl. reduction by gas-hydride, dehydride process, electro deposition, precipitation from aqueous solution and fused salts, hydrometallurgical method. Physical methods: Electrolysis and atomisation processes, types of equipment, factors affecting these processes, examples of powders produced by these methods, applications, powder conditioning, heat treatment, blending and mixing, types of equipment, types of mixing and blending

UNIT III POWDER COMPACTION
Pressureless compaction: slip casting and slurry casting. pressure compaction-lubrication, single ended and double ended compaction, isostatic pressing, powder rolling, forging and extrusion, explosive compaction.
UNIT IV  SINTERING
Stage of sintering, property changes, mechanisms of sintering, liquid phase sintering and infiltration, activated sintering, hot pressing and Hot Isostatic Pressing HIP, vacuum sintering, sintering furnaces and sintering atmosphere, finishing operations – sizing, coining, repressing and heat treatment.

UNIT V  APPLICATIONS

TOTAL : 45 PERIODS

TEXT BOOKS:

REFERENCES:

ML3213  SOLID STATE PHYSICS  L T P C
3 1 0 4

OBJECTIVES:
This subject provides the insight to physics of material starting with basics of matter waves, lattice vibrations and band theories to understand properties of metals, semiconductors, electric conductors, dielectrics, ferroelectrics, superconductors and thermal properties of materials

UNIT I  INTRODUCTION TO MODERN PHYSICS AND LATTICE DYNAMICS  9
Matter waves – Heisenberg’s uncertainty principle - Schrodinger’s time independent wave equation – Physical significance of wave function (y) – Application to a particle in a one dimensional box (infinite potential well)- Interatomic forces and lattice dynamics and simple metals, ionic and covalent crystals. Elastic waves in one dimensional array of identical atoms, vibrational modes of a diatomic linear lattice and dispersion relations, acoustic and optical modes, phonon dispersion relation.

UNIT II  BAND THEORY OF SOLIDS AND SEMICONDUCTOR PHYSICS  9
Fermi- Dirac distribution function, density of states, temperature dependence of Fermi energy, specific heat, use of Fermi- Dirac statistics in the calculation of thermal conductivity and electrical conductivity, Widemann -Franz ratio, susceptibility, width of conduction band, Drude theory of light, absorption in metals. Bloch theorem. Behaviour
of electrons in periodic potentials, Kronig-Penny model, E vs k relation, Density of states in a band, effective mass of electron, physical basis of effective mass, Intrinsic semiconductors. Band model, Fermi level, Expressions for electron and hole concentration in intrinsic and extrinsic semiconductors, Thermal ionization of impurities, Hall effect in semiconductors (p-type and n-type).

UNIT III DIELECTRICS AND FERROELECTRICS
Macroscopic description of the static dielectric constant. The electronic and ionic polarizabilities of molecules, orientational polarization, Measurement of the dielectric constant of a solid. The internal field of Lorentz, Clausium-Mosotti relation. Behaviour of dielectrics in an alternating field, elementary ideas on dipole relaxation, classification of ferroelectric crystals -BaTiO3 and KDP. Thermodynamics of ferroelectric crystals - Devonshire theory.

UNIT IV MAGNETISM

UNIT V SUPERCONDUCTIVITY
Occurrence of superconductivity, Destruction of superconductivity by magnetic fields Meissner effect, Heat capacity, Energy gap and Isotope effect. London's equations, Penetration depth, Coherence length, Cooper-pairs; elements of BCS theory, Giaver tunneling, Josephson effects (basic ideas), Elements of high temperature superconductivity (basic concepts only).

L : 45, T : 15, TOTAL : 60 PERIODS

TEXT BOOKS

REFERENCES
OBJECTIVE
The subject exposes students to the basics of polymer structure and their properties. Apart from Thermodynamics, the course imparts knowledge on processing polymers, i.e. by extrusion, moulding and fiber spinning.

UNIT I BASICS OF POLYMER PROCESS ENGINEERING 9

UNIT II THERMODYNAMICS OF POLYMERS 8
Rheology of Polymers – Dissolution of Polymers – Solubility parameter and its significance – Thermodynamic relations - Interrelation between polymer processing, structure and properties.

UNIT III EXTRUSION AND EXTRUSION BASED PROCESS 9

UNIT IV INJECTION MOULDING AND OTHER MOULDING PROCESS 10

UNIT V CALENDERING, FIBER SPINNING PROCESS AND OTHER PROCESS 8

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
OBJECTIVES:
Students should have knowledge on common metrological Instruments.

LIST OF EXPERIMENTS
1. Sine bar
2. Tool Makers Microscope
3. Rolling Gear tester
4. Comparator
5. Co-ordinate Measuring Machine
6. Surface finish measurement
7. Machine Vision System
8. Force Measurement
9. Torque Measurement

TOTAL : 45 PERIODS

OBJECTIVE
The practical knowledge is imparted to students in major areas of machining which has been studies in theory.

LIST OF EXPERIMENTS
1. Taper Turning
2. External Thread Cutting
3. Knurling
4. Shaping exercise – example hexagonal and square prisms
5. Drilling and Tapping
6. Determination of cutting forces in Turning and Milling Operations
7. Contour Milling using vertical milling machine
8. Gear hobbing
9. Gear shaping
10. Hexgonal machining using horizontal milling machine

TOTAL : 45 PERIODS
OBJECTIVES:
The basic knowledge on plasticity taught in mechanical metallurgy is extended to theory and applications of metal forming. Various metal forming process and their analysis are studied in detail.

UNIT I STRESS / STRAIN RATE TENSOR 10

UNIT II FUNDAMENTALS OF METAL FORMING 10

UNIT III FORGING AND ROLLING 9
Forging—types of presses and hammers. Classification, Open die forging and Closed die forging, die design, forging in plane strain, calculation of forging loads, forging defects—causes and remedies, residual stresses in forging. Rolling: Classification of rolling processes, types of rolling mills, hot and cold rolling, rolling of bars and shapes, forces and geometrical relationship in rolling, analysis of rolling load, torque and power, rolling mill control, rolling defects — causes and remedies.

UNIT IV EXTRUSION AND DRAWING 7
Direct and indirect extrusion, variables affecting extrusion, deformation pattern, equipments, port-hole extrusion die, hydrostatic extrusion, defects and remedies, simple analysis of extrusion, tube extrusion and production of seamless pipe and tube. Drawing of rods, wires and tubes.

UNIT V SHEET METAL FORMING AND OTHER PROCESSES 9
Forming methods — Shearing, blanking, bending, stretch forming, deep drawing. Types of dies used in press working defects in formed part, sheet metal formability, formability limit diagram.
High velocity forming: Comparison with conventional forming, Explosive forming, Electro hydraulic, Electro Magnetic forming, Dynapak and Petroforge forming.

T : 45+15 , TOTAL : 60 PERIODS

TEXT BOOKS

REFERENCES
OBJECTIVE
Material Properties have to suit the purpose of an application. When designing a machine or component, many factors have to be considered and optimised. This course covers most issues for mechanical design optimisation.

UNIT I MATERIAL SELECTION IN DESIGN

UNIT II MATERIALS PROCESSING AND DESIGN
Role of Processing in Designing – classification of manufacturing processes – types of processing systems – factors determining process selection. Design for manufacturability, assembly, machining, casting, forging and welding

UNIT III MANUFACTURING CONSIDERATIONS IN DESIGN
Surface finish – texture – dimensional tolerances in fitting – interchangeability – selective assembly – geometric tolerance. Selection of fits and tolerances

UNIT IV MATERIALS PROPERTIES AND DESIGN
Stress – Strain diagram – design for strength, rigidity – design under static loading, variable loading, eccentric loading – stress concentration. Design examples with shaft design, spring design and C-frames.

UNIT V MATERIALS IN DESIGN
Design for brittle fracture, fatigue failure, corrosion resistance. Designing with plastics, brittle materials

L : 45, T : 15, TOTAL : 60 PERIODS

TEXT BOOKS

REFERENCES
1. CES Materials Selector, GRANTA Design and M. F. Ashby, 2007
OBJECTIVE
Characterisation of materials is very important for studying the structure of materials and to interpret their properties. The students study the theoretical foundations of metallography, X-ray diffraction, electron diffraction, scanning electron microscopy, chemical and thermal analysis.

UNIT I METALLOGRAPHIC TECHNIQUES 8
Resolution, depth of focus and components of microscope, polarized light, phase contrast, interference microscopy, hot stage and quantitative metallographic techniques, specimen preparation techniques.

UNIT II X-RAY DIFFRACTION TECHNIQUES 10

UNIT III APPLICATION OF X-RAY DIFFRACTION 9
Diffractometer – general feature and optics, proportional, scintillating and Geiger counters. X-ray diffraction application in the determination of crystal structure, lattice parameter, phase diagram and residual stress – quantitative phase estimation, ASTM catalogue of Materials identification

UNIT IV ELECTRON MICROSCOPY 9

UNIT V ADVANCED CHEMICAL AND THERMAL ANALYSIS 9
Basic principles, practice and applications of X-ray spectrometry, X-ray photoelectron spectrometry, Auger spectroscopy, Differential thermal analysis DTA, Differential scanning calorimetry DSC and thermogravimetric analysis TGA

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
OBJECTIVE
This laboratory is elaborating on the multitude of heat treatment techniques, mainly applicable to iron, steel. It gives a comprehensive understanding of the changes in microstructure and property created by controlled heat treatment.

UNIT I TRANSFORMATIONS IN STEELS

UNIT II HEAT TREATMENT PROCESSES
Annealing, Normalizing, Hardening - retained austenite - measurement and methods of its elimination, hardenability studies- Jominy end quench test, Grossman's experiments Tempering- Hollomon & Jaffe tempering correlations, Austempering and Martempering, Precipitation hardening, thermomechanical treatment, intercritical heat treatment, other heat treatment processes - splat cooling.

UNIT III CASE HARDENING

UNIT IV HEAT TREATMENT EQUIPMENT
Various heating media used for heat treatment. Temperature and atmosphere control, carburising atmosphere and carbon potential measurement, nitriding gas atmospheres. Quenching media and their characteristics. Various heat treatment furnaces, fluidized bed furnaces, cryo chamber, cryo treatment of steels, sealed quenched furnace, plasma equipment.

UNIT V HEAT TREATMENT OF SPECIFIC ALLOYS

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES
INTRODUCTION TO NANOTECHNOLOGY

OBJECTIVE
This subject imparts basics of nanotechnology, their importance and tools to characterise nanostructures. The student are introduced to carbon nanotubes and few other nanostructured materials and their applications.

UNIT I INTRODUCTION
Moore’s law, silicon micro fabrication techniques such a photolithography/electron beam lithography and their advantages and limitations, importance of nanotechnology and its potential impacts, historical milestones in nanotechnology, prerequisites to make transition into nanotechnology era, proposed futuristic applications in nanotechnology and current state of the art.

UNIT II SCANNING PROBE MICROSCOPY
Tool for performing structural analysis at the nanometer scale and as a tool for nanopositioning. Operating principle of Scanning Tunnelling Microscope (STM), Atomic Force Microscope (AFM) and Scanning near Field Optical Microscope (SNFOM) and their applications by drawing on practical research examples. Advantages and disadvantages of SPM technique. Potentiality of SPM to overcome other complementary techniques.

UNIT III CHARACTERISATION OF NANOMATERIALS
Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) - applicability to characterize nanostructured materials.

UNIT IV CARBON NANOTUBES
Types of carbon nanotubes such as single-walled and multi-walled nanotubes, fabrication, physical and chemical properties, applications. Other carbon morphologies, bucky balls, graphenes.

UNIT V NANOSTRUCTURED MATERIALS
Liquid crystal templates: surfactants and their phase behaviour: formation of micelles and liquid crystal phases, for use as nanoscale moulds for templating, electroplating of nanostructured mesoporous films - physical properties of mesoporous nanostructured materials and applications (current and potential).

TOTAL : 45 PERIODS

TEXT BOOKS:

REFERENCES:

ML3306 \hspace{1cm} \textbf{CORROSION AND SURFACE ENGINEERING} \hspace{1cm} L T P C
\hspace{1cm} 3 \hspace{0.5cm} 0 \hspace{0.5cm} 0 \hspace{0.5cm} 3

\textbf{OBJECTIVE}

The subject provides knowledge on various types of corrosion, their kinetics, testing and methods of protection as well as introduction to tribology.

\textbf{UNIT I} \hspace{1cm} \textbf{INTRODUCTION} \hspace{1cm} 12

Introduction tribology, surface degradation, wear and corrosion, types of wear, adhesive, abrasive, oxidative, corrosive, erosive and fretting wear, roles of friction and lubrication, expressions for corrosion rate, emf and galvanic series - merits and demerits - Pourbaix diagram for iron, magnesium and aluminium. Forms of corrosion - Uniform, pitting, intergranular, stress corrosion. corrosion fatigue. dezincification. erosion corrosion, crevice corrosion - Cause and remedial measures - Pilling Bedworth ratio - High temperature oxidation.

\textbf{UNIT II} \hspace{1cm} \textbf{KINETICS OF CORROSION} \hspace{1cm} 8

Exchange current density, polarization - concentration, activation and resistance, Tafel equation; passivity, electrochemical behaviour of active/passive metals, Flade potential, theories of passivity, Effect of oxidising agents.

\textbf{UNIT III} \hspace{1cm} \textbf{CORROSION IN INDUSTRIAL PRACTICE} \hspace{1cm} 8

Atmospheric, pitting, dealloying, stress corrosion cracking, intergranular corrosion, corrosion fatigue, fretting corrosion and high temperature oxidation; causes and remedial measures, Corrosion failure – Inspection and analysis of corrosion damage.

\textbf{UNIT IV} \hspace{1cm} \textbf{TESTING} \hspace{1cm} 8

Purpose of corrosion testing - Classification - Susceptibility tests for intergranular corrosion- Stress corrosion test. salt spray test humility and porosity tests, accelerated weathering tests. ASTM standards for corrosion testing and tests for assessment of wear.

\textbf{UNIT V} \hspace{1cm} \textbf{PROTECTION METHODS} \hspace{1cm} 8

Electroless plating and Anodising - Cathodic protection, metallic, organic and inorganic coatings, corrosion inhibitors - principles and practice - inhibitors for acidic neutral and other media. Special surfacing processes - CVD and PVD processes, sputter coating. Laser and ion implantation. Arc spray. plasma spray. Flame spray. HVOF.

\textbf{TOTAL : 45 PERIODS}
TEXT BOOKS

REFERENCES

ML3307 HEAT TREATMENT LABORATORY L T P C 0 0 3 2

OBJECTIVE
This laboratory course offers practical knowledge of heat treatment applicable to iron and steel and studies microstructural changes and hardness evolution.

List of Experiments
1. Determination of grain size of low carbon steels
2. Annealing and normalising of carbon steels
3. Spheroidisation annealing of high carbon steels
4. Effect of quenching media on hardening of steel
5. Effect of tempering temperature and time on tempering of steel
6. Carburizing of steel
7. Case hardness depth measurements
8. Austempering treatment
9. Hardenability test (Grossman and/or Jominy)
10. Identification of defects in heat treated materials
11. Heat treatment of cast iron
12. Heat treatment of alloy steels
13. Heat treatment of non-ferrous alloys
14. Microstructure of heat treated steels

TOTAL : 45 PERIODS
OBJECTIVE
The students will learn to select an appropriate method and understand the process parameters influencing material processing. The student’s theoretical knowledge gained from powder metallurgy, polymer processing and heat treatments will guide them in understanding materials processing.

LIST OF EXPERIMENTS:
1. Hardness testing
2. Particle size distribution of powders
3. Liquid penetrant test
4. Ericson cup tester
5. Powder compaction
6. Sintering of powder compacts
7. Testing of Sintered powder compact
8. Casting experiments
9. Bulk forming experiments
10. Chemical route synthesis of powders

TOTAL : 45 PERIODS

ML3309 PRESENTATION SKILLS & TECHNICAL SEMINAR L T P C 0 0 2 1

To enrich the communication skills of the student and presentations of technical topics of interest, this course is introduced. In this course, a student has to present three Technical papers or recent advances in engineering/technology that will be evaluated by a Committee constituted by the Head of the Department.

ML3310 BIO AND SMART MATERIALS L T P C 3 0 0 3

OBJECTIVE
The students are introduced to functional materials such as smart and bio materials in this course.

UNIT I INTRODUCTION
UNIT II  ELECTRO-RHEOLOGICAL AND PIEZOELECTRIC SMART MATERIALS


UNIT III  SHAPE MEMORY (ALLOYS) SMART MATERIALS


UNIT IV  ORTHOPAEDIC AND CARDIOVASCULAR MATERIALS


UNIT V  DENTAL AND OTHER MATERIALS


TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
OBJECTIVE
The useful life of components are often limited by the fracture, fatigue and creep properties of the materials used. The students study the fundamental processes leading to failure of technical components.

UNIT I INTRODUCTION

UNIT II HIGH – TEMPERATURE DEFORMATION RESPONSE

UNIT III CYCLIC STRESS AND STRAIN FATIGUE
Macrofractrography fatigue failures - cyclic stress and strain controlled fatigue - Fatigue life estimation for notched components – Crack initiation mechanisms.

UNIT IV FATIGUE CRACK PROPAGATION
Stress and crack lengths correlations with FCP – Fracture modes in Fatigue – Microscopic fracture mechanisms – Crack growth behavior at ∆k extremes – Influences – Micro structural aspects of FCP in metal alloys.

UNIT V ANALYSIS OF ENGINEERING FAILURES
Typical defects – Microscopic surface examination – metallographic and fractographic examination – Component failure analysis – Fracture surface preservation – Cleaning and replication techniques and image interpretation.

TEXT BOOKS

REFERENCES
OBJECTIVES
- To introduce the concepts of Mathematical Modeling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems.

UNIT I INTRODUCTION

UNIT II ONE-DIMENSIONAL PROBLEMS

UNIT III TWO DIMENSIONAL SCALAR VARIABLE PROBLEMS

UNIT IV TWO DIMENSIONAL VECTOR VARIABLE PROBLEMS
Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

UNIT V ISOPARAMETRIC FORMULATION AND MISCELLANEOUS TOPICS

TEXT BOOKS

REFERENCES
OBJECTIVE
Composites are a relatively new class of materials. In this course the students learn about the benefits gained when combining different materials into a composite.

UNIT I  INTRODUCTION TO COMPOSITES  8

UNIT II  POLYMER MATRIX COMPOSITES  12

UNIT III  METAL MATRIX COMPOSITES  9

UNIT IV  CERAMIC MATRIX COMPOSITES  9

UNIT V  ADVANCES IN COMPOSITES  7

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
OBJECTIVE
To provide a clear understanding of basic management principles that leads to corporate building. Industrial Management deals with not only functions of management but also organizational structure and dynamics and includes modern concepts of Industrial Management

UNIT I
INTRODUCTION

UNIT II
FUNCTIONS OF MANAGEMENT

UNIT III
ORGANIZATIONAL BEHAVIOUR

UNIT IV
GROUP DYNAMICS

UNIT V
MODERN CONCEPTS

TOTAL : 45 PERIODS
TEXT BOOK

REFERENCES:

ML3315 COMPOSITE MATERIALS LABORATORY LT P C
0 0 3 2

OBJECTIVE
Students learn the fabrication processes of different composite materials and the mechanical characterization of these materials.

List of experiments
1. Fabrication of Continuous Fiber reinforced Polymer Composites
2. Fabrication of Dis-continuous Fiber reinforced Polymer Composites
3. Tensile Testing
4. Flexural strength
5. Hardness testing
6. Impact testing
7. Environmental Testing (Humidity and temperature)

TOTAL : 45 PERIODS

GE3318 COMMUNICATION SKILLS LABORATORY LT P C
0 0 4 2

Globalisation has brought in numerous opportunities for the teeming millions, with more focus on the students’ overall capability apart from academic competence. Many students, particularly those from non-English medium schools, find that they are not preferred due to their inadequacy of communication skills and soft skills, despite possessing sound knowledge in their subject area along with technical capability. Keeping in view their pre-employment needs and career requirements, this course on Communication Skills Laboratory will prepare students to adapt themselves with ease to the industry environment, thus rendering them as prospective assets to industries. The course will equip the students with the necessary communication skills that would go a long way in helping them in their profession.

OBJECTIVES:
- To equip students of engineering and technology with effective speaking and listening skills in English.
- To help them develop their soft skills and interpersonal skills, which will make the transition from college to workplace smoother and help them excel in their job.
To enhance the performance of students at Placement Interviews, Group Discussions and other recruitment exercises.

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<th>I. PC based session (Weightage 40%)</th>
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<td>A. ENGLISH LANGUAGE LAB (18 Periods)</td>
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1. LISTENING COMPREHENSION: (6)
   Listening and typing – Listening and sequencing of sentences – Filling in the blanks - Listening and answering questions.

2. READING COMPREHENSION: (6)
   Filling in the blanks - Close exercises – Vocabulary building - Reading and answering questions.

3. SPEAKING: (6)

   Conversations: Face to Face Conversation – Telephone conversation – Role play activities (Students take on roles and engage in conversation)

B. DISCUSSION OF AUDIO-VISUAL MATERIALS (6 PERIODS)
   (Samples are available to learn and practice)

1. RESUME / REPORT PREPARATION / LETTER WRITING (1)
   Structuring the resume / report - Letter writing / Email Communication - Samples.

2. PRESENTATION SKILLS: (1)
   Elements of effective presentation – Structure of presentation - Presentation tools – Voice Modulation – Audience analysis - Body language – Video samples

3. SOFT SKILLS: (2)
   Time management – Articulateness – Assertiveness – Psychometrics – Innovation and Creativity - Stress Management & Poise - Video Samples

4. GROUP DISCUSSION: (1)
   Why is GD part of selection process ? - Structure of GD – Moderator – led and other GDs - Strategies in GD – Team work - Body Language - Mock GD -Video samples

5. INTERVIEW SKILLS: (1)
   Kinds of interviews – Required Key Skills – Corporate culture – Mock interviews- Video samples.

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<th>II. Practice Session (Weightage – 60%)</th>
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<td>1. Resume / Report Preparation / Letter writing: Students prepare their (2)</td>
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own resume and report.

2. **Presentation Skills:** Students make presentations on given topics. (8)

3. **Group Discussion:** Students participate in group discussions. (6)

4. **Interview Skills:** Students participate in Mock Interviews (8)

**TEXT BOOKS**


**REFERENCES**


**LAB REQUIREMENT**

1. Teacher console and systems for students.

2. English Language Lab Software

3. Career Lab Software
Requirement for a batch of 60 students

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ML3317 ADVANCED MATERIALS CHARACTERIZATION L T P C LABORATORY 0 0 3 2

OBJECTIVE
This laboratory gives practical exposure characterization techniques and teaches to interpret results with knowledge gained from the theory subject on characterization of materials.

LIST OF EXPERIMENTS:

1. Identification of phase
2. Cell parameters calculation
3. Biphasic composition weight percentage based on X-ray diffraction
4. Nanosize determination
5. SEM topography
6. Indexing of selected area electron diffraction pattern
7. Image analysis of microstructures

TOTAL : 45 PERIODS
UNIT I  INTRODUCTION
Introduction - Need for quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM Framework - Contributions of Deming, Juran and Crosby – Barriers to TQM.

UNIT II  TQM PRINCIPLES
Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDSA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III  TQM TOOLS & TECHNIQUES I

UNIT IV  TQM TOOLS & TECHNIQUES II

UNIT V  QUALITY SYSTEMS

TOTAL: 45 PERIODS

TEXT BOOK:

REFERENCES:
OBJECTIVES
Computer applications have become important to solve, approximate, interpret and visualize problems in Materials Science. After reviewing the mathematical foundation, applications in Materials Science are introduced.

UNIT I SOLUTIONS OF EQUATIONS AND INTERPOLATION

UNIT II PARTIAL DIFFERENTIAL EQUATIONS

UNIT III MONTE CARLO METHODS AND SIMULATION

UNIT IV MATRIX ALGEBRA

UNIT V SELECTED APPLICATIONS IN MATERIALS SCIENCE
Modeling and property prediction.

TEXTBOOKS

REFERENCES
OBJECTIVE
Study most important Non Destructive Testing methods, theory and their industrial application.

UNIT I INTRODUCTION TO NON DESTRUCTIVE TESTING
Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Comparison of advantages and limitations of different NDT methods. Visual inspection

UNIT II SURFACE NDT, LIQUID PENETRANT (LT), MAGNETIC PARTICLE TESTING (MT)
MT: Magnetisation methods, evaluation of results.

UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING (ET)
Active and Passive Thermography, Application in flaw detection.
ET: Principles, permeability and conductivity, Testing for defects, material characterisation and sorting

UNIT IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE)

UNIT V RADIOGRAPHY (RT)
Principle, interaction of X-Ray with matter, imaging, film and film less techniques, Computed Radiography, Computed Tomography

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES
AIM
To enable students to study the process of joining by welding in detail.

OBJECTIVES
Welding is one of the most important fabrication processes in industry and requires both theoretical understanding and experience of materials used in industry. This can be achieved in this course.

UNIT I  WELDING METALLURGY PRINCIPLES  9
Thermal cycles in welding: basic heat transfer equations, temperature distributions and cooling curves, dependence of cooling rate on heat input, joint geometry, preheat and other factors. Comparison of welding processes based on these considerations.

UNIT II PHYSICAL METALLURGY OF WELDING  9

UNIT III WELDING OF ALLOY STEELS  9
Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron.

UNIT IV WELDING OF NON-FERROUS METALS  9
Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions.

UNIT V DEFECTS AND WELDABILITY  9
Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, testing of weldability.

TOTAL : 45 PERIODS

TEXT BOOKS:

REFERENCES:
LIST OF EXPERIMENTS

A. SIMULATION
MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables
Use of Matlab to solve simple problems in vibration and Laplace Transforms

B. Analysis (Simple Treatment only)
1. Stress analysis of a plate with a circular hole.
2. Stress analysis of rectangular L bracket
3. Stress analysis of plane strain problems
4. Stress analysis of an axi-symmetric components
5. Stress analysis of beams (Cantilever, Simply supported, Fixed ends)
6. Mode frequency analysis of a 2D component
7. Mode frequency analysis of beams (Cantilever, Simply supported, Fixed ends)
8. Harmonic analysis of a 2D component
9. Transient analysis of spring mass system
10. Spectrum analysis of spring mass system
11. Thermal stress analysis of a axisymmetric component
12. Conductive heat transfer analysis of a 2D component
13. Convective heat transfer analysis of a 2D component

TOTAL : 45 PERIODS

The objective of this comprehension is to achieve an understanding of the fundamentals of contemporary manufacturing systems including materials, manufacturing process, product and process control and quality assurance. The students work in groups and solve a variety of problems given to them. The problems given to the students should be of real life industrial problems selected by a group of faculty members of the concerned department. A minimum of three small problems have to be solved by each group of students. The evaluation is based on continuous assessment by a group of Faculty Members constituted by the professor in – charge of the course.

TOTAL : 30 PERIODS
OBJECTIVE
The main objective is to impart hands on training to the students in the fabrication of one or more component of a complete working model, which has been designed by them. The transfer of concepts studied in the Materials Science Programme to a practical application is important.

Students get familiarized in the field of material synthesis or processing, metal joining or casting or forming, or mechanical behavior of materials or material characterization or material testing and analysis. The project can also focus on the selection and optimization of materials in design of on a purely material oriented project such as the development and characterization of an alloy.

The students may be grouped in small groups and work under a project supervisor. The components to be fabricated may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the group, which will be evaluated by a Committee which will be constituted by the Head of the Department

TOTAL : 60 PERIODS

OBJECTIVE
This course is mandatory to gain exposure to applications in industry.

The students have to undergo practical industrial training for six weeks (during vacation at the end of VI semester) in recognized industrial establishments. At the end of the training they have to submit a report with following information:
Profile of the Industry

1. Product range
2. Organization structure
3. Plant layout
4. Processes/Machines/Equipment/devices
5. Personnel welfare schemes
6. Details of the training undergo
7. Projects undertaken during the training, if any
8. Learning points.
9. End Semester examination will be a Viva-Voce Examination.
OBJECTIVES:
In the project work the students demonstrate their ability to apply knowledge studied during the course. Students show their ability to collect information from literature, design, perform and interpret experiments. The successful project work is documented in a formal project report and technical presentation.

A project topic must be selected either from published lists or the students themselves may propose suitable topics in consultation with their guides. The aim of the project work is to deepen comprehension of the principles by applying them to a new problem which may be the design and manufacture of a device, a research investigation, a computer or management project or design problem. The problem may be selected in areas of material synthesis or processing, material characterization, material joining, metal forming or casting or mechanical behaviour of materials or material testing and analysis.

The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department.

A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.

ML3001 METALLURGY OF TOOL MATERIALS

OBJECTIVE
Tooling materials require special considerations in production and application. Students will learn the metallurgical processes and applications in producing toolings.

UNIT I CLASSIFICATION AND MANUFACTURE OF TOOL STEELS 8
Classification - AISI system, production techniques – problems in melting - powder metallurgy route, Refining methods like VAR and ESR - forming of tool steels.

UNIT II HEAT TREATMENT OF TOOL STEELS 10
Spheroidising – selection of quenching and tempering parameters – precautions - Effect of retained austenite - Multiple tempering, sub-zero treatment and cryo treatment - surface treatments - defects in tool steels - Over heated and burnt structures - Decarburization.

UNIT III PROPERTIES AND TESTING OF TOOL STEELS 10
Mechanical properties of tool steels, strength, hardness and toughness – properties at elevated temperature – microstructure - distribution of carbides - coating thickness – micro hardness – adhesion and scratch resistance

UNIT IV ADVANCED TOOL MATERIALS 10
UNIT V    SURFACE TREATMENTS AND COATINGS    7
Sulphidising of tool steels – TiN coating by PVD – coating of carbide tools – mono and multi layer coatings of TiC, TiN, Alumina and DLC by PVD and CVD processes - selection of tool materials

TOTAL : 45 PERIODS

TEXT BOOK

REFERENCES

ML3002    PHYSICAL METALLURGY OF FERROUS AND ALUMINUM ALLOYS    L T P C
OBJECTIVES
Students of Materials Science and Engineering are offered an in depth study of the physical metallurgy of ferrous and aluminum alloys.

UNIT I    PHASE TRANSFORMATION    8
Basics of thermodynamics, kinetics and diffusion mechanisms.

UNIT II    DIFFUSION CONTROLLED PHASE TRANSFORMATION    10

UNIT III    DIFFUSIONLESS TRANSFORMATIONS    10
Martensite transformation - Definition - characteristic features of Martensitic transformation in steels - morphology of Martensite - lath and acicular martensite - Crystallography of martensitic transformation - Martensite in non-ferrous systems - Thermoelastic martensite - Shape Memory effect - Examples and applications of shape memory alloys.

UNIT IV    PRECIPITATION REACTIONS    7
Precipitation from solid solutions, thermodynamic considerations, structure and property during ageing, sequence of ageing, formation of G-P zones and intermediate precipitates, theories of precipitation hardening, effect of time, temperature and alloy compositions, precipitation free zones, crystallographic aspects of transformation, coarsening kinetics.

UNIT V    ANNEALING    8
Cold working and hot working. Recovery - polygonization and dislocation movements in polygonization. Recrystallisation - effect of time, temperature, strain and other variables,

**TEXT BOOKS:**


**REFERENCES:**


**MA2264 NUMERICAL METHODS**

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**AIM**

With the present development of the computer technology, it is necessary to develop efficient algorithms for solving problems in science, engineering and technology. This course gives a complete procedure for solving different kinds of problems occur in engineering numerically.

**OBJECTIVES**

- At the end of the course, the students would be acquainted with the basic concepts in numerical methods and their uses are summarized as follows:
- The roots of nonlinear (algebraic or transcendental) equations, solutions of large system of linear equations and eigen value problem of a matrix can be obtained numerically where analytical methods fail to give solution.
- When huge amounts of experimental data are involved, the methods discussed on interpolation will be useful in constructing approximate polynomial to represent the data and to find the intermediate values.
- The numerical differentiation and integration find application when the function in the analytical form is too complicated or the huge amounts of data are given such as series of measurements, observations or some other empirical information.
- Since many physical laws are couched in terms of rate of change of one/two or more independent variables, most of the engineering problems are characterized in the form of either nonlinear ordinary differential equations or partial differential equations. The methods introduced in the solution of ordinary differential equations and partial differential equations will be useful in attempting any engineering problem.
UNIT I  SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS

UNIT II  INTERPOLATION AND APPROXIMATION
Lagrangian Polynomials – Divided differences – Interpolating with a cubic spline – Newton’s forward and backward difference formulas.

UNIT III  NUMERICAL DIFFERENTIATION AND INTEGRATION

UNIT IV  INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS

UNIT V  BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS
Finite difference solution of second order ordinary differential equation – Finite difference solution of one dimensional heat equation by explicit and implicit methods – One dimensional wave equation and two dimensional Laplace and Poisson equations.

L = 45 , T = 15, TOTAL: 60 PERIODS

TEXT BOOKS

REFERENCES
OBJECTIVE
Students are to learn about metal cutting operations from the theoretical and practical perspective.

UNIT I CUTTING TOOL NOMENCLATURE
9
Single point tool-significance of the various angles - Machine reference system- normal tool reference system- ORS – interrelation between different tool nomenclatures - Nomenclature of drills, milling cutters and broaches

UNIT II CHIP FORMATION MECHANISM AND FORCES IN MACHINING
10
Orthogonal and oblique cutting - Mechanisms of formation of chips-types of chips - Merchant's circle diagram-Force and Velocity relationship, shear plane angle, Energy considerations in matching-Ernst Merchant’s theory of shear angle relationship - Forces in turning, drilling, milling and grinding- specific cutting pressure-specific horse power-construction and principle of operation of tool dynamometers for turning, drilling and milling.

UNIT III THERMAL ASPECTS IN MACHINING, TOOL WEAR AND TOOL LIFE
10

UNIT IV CUTTING TOOL MATERIALS
8
Requirements of tool materials-properties of HSS - advances in tool materials- carbides and coated carbides, ceramic, cermets, CBN, Diamond, PCD - ISO-specifications for inserts and tool holders - -Need for chip breakers – types of chip breakers

UNIT V MODELING OF METAL CUTTING
8
Introduction to modeling – empirical models – mechanistic models – FEA based models – artificial intelligence based models for turning, milling and drilling

REFERENCES:
UNIT I  ENGINEERING ETHICS  9
Senses of ‘Engineering Ethics’ – Variety of moral issues – Types of inquiry – Moral
dilemmas – Moral Autonomy – Kohlberg’s theory – Gilligan’s theory – Consensus and
Controversy – Professions and Professionalism – Professional Ideals and Virtues –
Uses of Ethical Theories

UNIT II  ENGINEERING AS SOCIAL EXPERIMENTATION  9
Engineering as Experimentation – Engineers as responsible Experimenters – Research
Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The
Challenger Case Study

UNIT III  ENGINEER’S RESPONSIBILITY FOR SAFETY  9
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing
Risk – The Government Regulator’s Approach to Risk - Chernobyl Case Studies and
Bhopal

UNIT IV  RESPONSIBILITIES AND RIGHTS  9
Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality
– Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights –
Intellectual Property Rights (IPR) - Discrimination

UNIT V  GLOBAL ISSUES  9
Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics -
Role in Technological Development – Weapons Development – Engineers as Managers
– Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty –
Moral Leadership – Sample Code of Conduct

TOTAL: 45 PERIODS

TEXT BOOKS:
   2005.

REFERENCES:
1. Charles D Fleddermann, “Engineering Ethics”, Prentice Hall, New Mexico,
   1999.
4. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, “Business Ethics – An Indian
MF3304        COMPUTER AIDED DESIGN        LT PC
                                      3 0 0 3

AIM:
To impart knowledge in the theoretical principles of Computer Aided Design

OBJECTIVE:
To familiarize the student with computer hardware and peripheral
Devices, mathematics of computer graphics, geometric modeling, CAD standards
And to impart fundamental knowledge in Finite Element Analysis

UNIT I    INTRODUCTION     5
Product Cycle – Design Process – CAD Hardware – Mainframe, Mini, Workstation and
Micro computer Based Systems, Input and Output Devices – Software – Operating
System, Geometric Modeling capabilities – hardware Integration and Networking.

UNIT II   COMPUTER GRAPHICS    9
Two dimensional transformations – Transformation of Straight Lines – Rotation –
Reflection – Scaling – Combined Transformations – Translations and homogeneous co
ordinates – Three dimensional transformations – Scaling – Rotation – Reflection –
Translation – Projections – Orthographic and Isometric Projections – Clipping – Hidden
Line and Surface Removal.

UNIT III  GEOMETRIC MODELLING   9
Geometrical Modeling – wire frame, models – entities – surface models – entities – solid
models – Entities – Boundary Representation (B-Rep) – Constructive Solid Geometric
(CSG) – Sweep and Analytical Solid Modeling.

UNIT IV   CAD STANDARDS     11
Graphical Kernel System (GKS) Programmers Hierarchical Interface for Graphics
(PHIGS), Initial Graphics Exchange Specification (IGES), Standard for Exchange of
product Model Data (STEP), Drawing Exchange Format (DXF), Dimensional
Measurement Interface Specification (DMIS) – Introduction to Drafting and Modeling
Systems.

UNIT V    FINITE ELEMENT ANALYSIS   11
Introduction – Procedures – Element types – Nodal approximation – Element matrices,
vectors and equations – Global connectivity – Assembly – Boundary conditions –
Solutions techniques – Interfaces to CAD – Introduction to packages, Case Studies –
Applications.

TOTAL: 45 PERIODS

TEXT BOOKS
   1991

REFERENCES
   Age International Ltd., 1994.
OBJECTIVE
The students study the processes and special requirements of the Automotive Industry.

UNIT I PROPERTIES OF MATERIALS 10
Technologically important properties of materials, Physical, Chemical, Mechanical and Electrical properties of metals, Criteria of selection of materials like properties, cost, manufacturing process, availability, legal and safety factors.

UNIT II MATERIALS FOR CORROSION AND WEAR RESISTANCE 8
Materials for atmospheric, soil, water, acid and alkaline resistance, Corrosion prevention coatings, material for Chemical and Petroleum industries, materials and coatings for wear resistance.

UNIT III MATERIALS FOR HIGH AND LOW TEMPERATURES 8
High temperature strength and stability, Hot hardness requirements, High temperature steels and super alloys, ductile to brittle transition-HSLA steel, low temperature materials.

UNIT IV MATERIALS FOR AUTOMOTIVE INDUSTRY 10
Materials for engine components, cylinder block, head, Liner, piston, ring, pin, connecting rod, crank shaft, exhaust, cam shaft, rocker arm and tappet, etc. Materials for chasis

UNIT V NEW MATERIALS 9
New Materials and processes Rheology, Recycling requirements.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
OBJECTIVES
Students are learning medical and biomedical applications of materials. Biocompatibility

UNIT I BIOLOGICAL PERFORMANCE OF MATERIALS 9
Biofunctionality and biocompatibility - material response - deformation and failure - friction and wear - Host response - Inflammatory process - capsule formation - coagulation and hemolysis - approach to thromboreistant material development - chemical and foreign body carcinogenesis.

UNIT II ORTHOPAEDIC MATERIALS 9

UNIT III DENTAL AND CARDIOVASCULAR MATERIALS 9

UNIT IV ARTIFICIAL ORGANS AND OTHER MATERIALS 9

UNIT V MATERIALS CHARACTERIZATION TECHNIQUES 9
Electron microscopic methods - SEM, TEM, spectroscopic methods - IR; visible, UV and x-ray methods, differential thermal analysis, differential thermogravimetric analysis, NDT methods.

TOTAL: 45 PERIODS

TEXT BOOKS

REFERENCES
OBJECTIVE
The study of microstructure and microscopic properties are important tools for the understanding of material behaviour. This course covers, crystal structure, X-Ray methods and spectroscopy as well as scanning and transmission electron microscopy.

UNIT I CRYSTALLOGRAPHY

UNIT II DIFFRACTION AND CHARACTERISTICS X-RAYS

UNIT III SINGLE CRYystal DIFFRACtioN

UNIT IV SPECTROSCOPY
Principles and instrumentation for X-ray photoelectron spectroscopy (XPS), Auger Electron spectroscopy (AES) and Secondary ion mass spectroscopy (SIJMS) – proton induced X-ray Emission spectroscopy (PIXE)

UNIT V OPTICAL METHODS AND ELECTRON MICROSCOPY

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES
OBJECTIVES
Many industries require process heat in the production and treatment of materials. This course teaches fundamentals and applications of fuels, furnaces and refractories.

UNIT I  FUNDAMENTALS  9

UNIT II  FUELS  9

UNIT III  FURNACES  9
Firing, electric Resistance, Radiation, Induction. Temperature control - PID. Multi zone furnaces. Batch and tunnel furnaces.

UNIT IV  REFRACTORIES  9
Heat resistant materials in steel making and non ferrous production plants. Applications in the power, energy conversion, petroleum and chemical industries.

UNIT V  ADVANCED ISSUES  9

TOTAL : 45 PERIODS

TEXT BOOKS:

REFERENCES:
UNIT I SURFACES AND FRICTION

UNIT II WEAR

UNIT III LUBRICANTS AND LUBRICATION TYPES

UNIT IV FILM LUBRICATION THEORY

UNIT V SURFACE ENGINEERING AND MATERIALS FOR BEARINGS

TEXT BOOK:

REFERENCES:
OBJECTIVES
Many materials have different properties on a micro and nano scale as compared to bulk material. This difference and special properties only relevant to nano scale material are elaborated on in this course and should be mastered by the students.

UNIT I INTRODUCTION 5
Overview of the composition, structure, chemical and mechanical properties of surfaces and how these properties affect mechanical and tribological properties of surfaces.

UNIT II MICROMECHANICS 5
Multiscale interactions between surfaces; fractal nature of surface topography; interfacial forces, adhesion, and principles of micromechanics; techniques for surface characterization.

UNIT III DEFORMATION MECHANISMS 15
Stress and strain of material; Elastic deformation: Young's modulus, Poisson's ratio, stress-strain relation, stiffness/compliance matrix; Dislocations: Edge/screw/mixed dislocation, burgers vectors, twining, stress field of dislocation, dislocation interaction; Plastic deformation of single and polycrystalline materials: Schmid’s law, plastic flow; Inelastic deformation: Viscosity, deformation of inorganic glasses, deformation of nanocrystalline and crystalline polymers; Mechanical fracture: ductile and brittle fracture, creep, fatigue;

UNIT IV TESTING METHODS 5

UNIT V NANOMECHANICAL PROPERTIES 10
Determination of surface mechanical properties (AFM/nanoindentation), simple friction theories - effects of surface composition and structure on friction, environmental and temperature effects, relationship with surface chemistry, mixed and boundary lubrication, failure mechanisms

REFERENCES:
OBJECTIVE
The casting of metals is the focus of this course and covers not only steels, but also light metals like Magnesium and Aluminum. The casting of Zinc and Copper alloys is also treated in detail.

UNIT I MAGNESIUM ALLOYS 8
Introduction to different types of Magnesium alloys – Process for Manufacturing Magnesium alloys – Production considerations – Die casting consideration – die life productivity – applications of Magnesium alloy cast parts.

UNIT II ALUMINIUM ALLOYS 10

UNIT III ALLOY STEELS 10
Introduction to different types of Alloy steels – process for manufacturing alloy steels – production considerations – productivity – applications of alloy cast parts.

UNIT IV ZINC ALLOYS 8

UNIT V COPPER ALLOYS 9

TOTAL : 45 PERIODS

TEXT BOOKS:

REFERENCES:
OBJECTIVES
This course deals with the bulk forming processes in rolling and forging operations. Students should learn the foundations to be able to apply this knowledge in industrial environments.

UNIT I  BULK AND DEFORMATION PROCESS
Characteristics – applications of Bulk Deformation Process, Deformation mechanics – Material requirements – Friction in bulk deformation, environmental factors.

UNIT II  ROLLING PROCESS

UNIT III  SPECIAL ROLLING PROCESS

UNIT IV  HOT FORGING PROCESS

UNIT V  COLD FORGING

TOTAL : 45 PERIODS

TEXT BOOKS:

REFERENCES:
AIM
The purpose of this subject is understand the principles of various micro fabrication processes.

OBJECTIVES
- Upon completion of this subject, student will be able to:
- Understand principle of micro systems and feedback systems
- Know the different methods of microfabrication.
- Understand the properties and microstructure of materials
- Appreciate integration processes in detail
- Enhance the knowledge in semiconductor manufacturing processes.

UNIT I INTRODUCTION
Introduction to Micro System design, Material properties, micro fabrication technologies. Structural behavior, sensing methods, micro scale transport - feedback systems.

UNIT II MICROMECHANICS
Microstructure of materials, its connection to molecular structure and its consequences on macroscopic properties – Phase transformations in crystalline solids including martensite, ferroelectric, and diffusional phase transformations, twinning and domain patterns, smart materials

UNIT III BASIC MICRO-FABRICATION

UNIT IV MECHANICAL MICROMACHINING

UNIT V SEMI CONDUCTORS MANUFACTURING

TOTAL : 45 PERIODS

TEXT BOOK:

REFERENCES:
OBJECTIVE
In this course the structure and properties of ceramics, classes and refractory materials is studied in detail.

UNIT I  FUNDAMENTALS  9
Ceramic crystal structures. NaCl, CsCl, Al2O3 Phase diagram SiO2 – K2O – Al2O3. Classifications by application (density, porosity), composition (oxides, carbides, nitrides), properties

UNIT II  RAW MATERIALS AND CHARACTERIZATION  9
Mineralogy, Phase analysis, powder classification

UNIT III  GLASS  9
Silica-soda-lime glasses. Structure, composition, raw materials, furnaces, melting reactions, production routes, Products (flat, containers), optical glass, optical fibers

UNIT IV  CERAMICS  9
Requirements of tool materials-properties of HSS - advances in tool materials- carbides and coated carbides, ceramic, cermets, CBN, Diamond, PCD - ISO-specifications for inserts and tool holders - -Need for chip breakers – types of chip breakers

UNIT V  ADVANCED CERAMICS  9
Applications in structural (ICE, gas turbines, cutting tools), bioceramics (implants), electrical (insulators, substrates, piezoceramics), ceramic coatings (thermal barriers), nuclear (cermets), process (filters, catalyst)

TOTAL : 45 PERIODS

TEXT BOOK

REFERENCES
OBJECTIVES
Students should master the foundation and applications of experimental mechanics which is important for all machining operations.

UNIT I INTRODUCTION

UNIT II TOOL WEAR EVALUATION

UNIT III TECHNIQUES FOR STUDYING COMPOSITION AND STRUCTURE

UNIT IV MEASUREMENT OF CUTTING FORCE AND DYNAMOMETERS
Forces involved in machining mechanical – hydraulic and electrical dynamometers – amplifiers and recorders measurement of forces in drilling – dynamometer for milling – dampers for dynamometer.

UNIT V ANALYSIS OF EXPERIMENT DATA

TOTAL : 45 PERIODS

TEXT BOOK

REFERENCES
OBJECTIVES
After studying stress and strain in the core mechanical subjects, this elective should train the students to apply practical methods of experimental stress analysis.

UNIT I INTRODUCTION

UNIT II BRITTLE COATING METHODS

UNIT III PHOTO ELASTICITY METHODS
Stress optic law in two dimensions at normal incidence – Effect of stress model in a plane polariscope - Circular polariscope ( Dark field – light field) – Fringe multiplication by photographic methods. Holography

UNIT IV STRAIN MEASUREMENTS

UNIT V STRAIN GAGE CIRCUITS

TOTAL : 45 PERIODS

TEXT BOOK:

REFERENCES:
OBJECTIVES
Students are to be trained in modern laser processing methods that include machining and cutting, but also a way of localized heat treatment not available with conventional ways of introducing heat in a metal.

UNIT I LASER SYSTEMS
Laser beam characteristics – laser principles – High power lasers for materials applications – principles and working of CO₂, Nd:YAG and Excimer laser – Optics for irradiation

UNIT II THERMAL PROCESS IN INTERACTION ZONES
Laser Materials processing parameters – conduction and convection – Analytical models in one dimensional heat flow – depth of irradiation with respect to energy density – reflectivity of material with respect to wave length – rate of heating, cooling and temperature gradient.

UNIT III LASER METALLURGY

UNIT IV LASER CUTTING AND DRILLING

UNIT V LASER WELDING
Process mechanisms (Key hole and Plasmas) – operating characteristics – process variations – imperfections- industrial applications –recent developments

TEXT BOOK:

REFERENCES:
OBJECTIVE
Students are to study and become familiar with this very specialized form of material treatment at low temperature.

UNIT I  INTRODUCTION

UNIT II  CRYOCOOLERS

UNIT III  CRYOGENIC PROCESSING
Historical Development of Cryogenic Treatment, Cryogenic for Ferrous Metals, Need for cryogenic treatment, Types of low temperature treatment and processors, Benefits of cryogenic treatment-Wear resistance, Stress Relieving, Mechanism for cryogenic treatment, Characterization of cryogenically processed materials.

UNIT IV  MATERIALS ENGINEERING
Trends and advances in cryogenic materials, History and applications of nonmetallic materials, Understanding properties and fabrication processes of superconducting Nb$_3$Sn wires, High temperature superconductors.

UNIT V  APPLICATIONS
Applications of Cryogenics in Space Programs, Superconductivity, Medical applications, Food Preservation-Individual Quick Freezing.

TOTAL : 45 PERIODS

TEXT BOOK:

REFERENCES:
AIM
This subject is expected to imbibe knowledge on materials handling system which are essential for industries ranging from heavy works to semiconductor devices manufacturing.

OBJECTIVE
This course is practically oriented for the needs of industry. Students are to master materials handling systems for flow, transport and assembly operations in production lines.

UNIT I PLANT LAYOUT AND MATERIAL HANDLING PRINCIPLE
Plant Layout: Need for layout planning, Layout objectives and Determinants, Types of Layout, Computer Aided Plant Layout Planning: CRAFT, ALDEP, and CORELAP. Material Handling objective, benefits of better handling, relationship between layout and material handling, principles of Material Handling, Unit load concept, Material Handling Types, Equipment selection and Applications.

UNIT II MECHANIZED ASSEMBLY
Principles and operating characteristics of part feeders such as vibratory bowl feeder, Reciprocating tube hopper feeder, Centrifugal hopper feeder, Center board hopper feeder, Orientation of parts: In bowl and out bowl tooling, different types of Escapement, Transfer Systems and Indexing Mechanism.

UNIT III MATERIAL TRANSPORT AND STORAGE SYSTEM
Industrial trucks: non powered and powered industrial trucks, AGVS : Types, Vehicle guidance technology, traffic and safety, Monorail and other rail guided vehicles, types of cranes, hoists and elevators.

UNIT IV CONVEYORS TYPES AND STORAGE SYSTEM
Belt conveyors, Slat conveyors, Gravity conveyors, Apron, escalators, pneumatic conveyors, screw conveyors, vibrating conveyor, Analysis of material transport system. Automated Storage system, AS/RS System, Carousel storage system, WIP storage system.

UNIT V PACKAGING AND ECONOMIC ANALYSIS OF MATERIAL HANDLING EQUIPMENTS
Packaging: Functions, materials, palletizing, packaging equipments. Economic Analysis of material handling equipment: Factors in material handling selection, break event analysis, equipment operating cost per unit distance, work volume analysis – illustrative problems, productivity / indicator ratios.

TOTAL : 45 PERIODS

TEXT BOOKS

REFERENCES

ML3007 MODELING AND SIMULATION IN MATERIALS ENGINEERING

OBJECTIVES:
Modeling and simulation are important tools in understanding physical effects in many technological applications. This course should enable students to use standard packages for modeling and simulation applicable to Materials Science and Engineering.

UNIT I INTRODUCTION TO MODELING AND MATHEMATICAL CONCEPTS 9
Mathematical modeling, physical simulation, advantages and limitations - Review of differential equations, numerical methods, introduction to FEM, FDM - Governing differential equations of elastic, plastic deformation, fluid flow and heat transfer – basic steps in FEM

UNIT II CONSTITUTIVE MODELING 9
Elastic Medium, visco-elastic constitutive equations.

UNIT III CONSTITUTIVE MODELING 9
Plastic Medium.

UNIT IV SOFTWARE PACKAGES 9
Introduction to standard software packages – General purpose FEA packages such as ANSYS, ABAQUS, NASTRAN etc. – Special purpose packages such as DEFORM, OPTIFORM, ProCAST, etc. - Applications of FEA in simulation of sheet metal and bulk forming, solidification of casting and weldment, Concepts of coupled analysis

UNIT V COMPUTER APPLICATIONS IN PHYSICAL METALLURGY 9
Use of computers for the construction of phase diagrams, Features of CALPHAD – Expert system for alloy design and selection of materials – computer applications in crystallography.

TOTAL : 45 PERIODS

TEXT BOOKS
REFERENCES

ML3023 POLYMER RHEOLOGY LT P C 3 0 0 3

OBJECTIVE
Students have studied the fundamentals of plastics from the point of structure and properties. In this course the rheological aspects of production should be understood in detail.

UNIT I INTRODUCTION TO POLYMER RHEOLOGY 9
Rheology- Classification of fluid behaviour – Elastic, viscous and viscoelastic – Newtonian and non-newtonian fluids – Pseudo plastic and dilatant fluids – Stress, strain – Rate of strain/shear – Relation between them – Viscosity of Polymer Systems – MFI.

UNIT II PRINCIPLES OF POLYMER RHEOLOGY 9

UNIT III FACTORS INFLUENCING POLYMER RHEOLOGY 9

UNIT IV RHEOMETRY AND TESTING METHODS 9
Rheological measurements – Capillary viscometer – Rotary rheometer – Cone & Plate (C-P), Plate-Plate (P-P) and concentric cylindrical viscometer – Static and Dynamic Tests – Mechanical models of viscoelastic systems – Maxwell & VOIGT Kelvin – Polymer Viscoelasticity.

UNIT V RHEOLOGY IN PLASTICS AND RUBBER PROCESSING 9

TOTAL : 45 PERIODS
TEXT BOOK:

REFERENCES:

ML3024 FRACTURE MECHANICS & FAILURE ANALYSIS

OBJECTIVE
After completion of this course, students should have been understood causes of fracture and failure on the basis of fracture mechanics.

UNIT I ELEMENTS OF SOLID MECHANICS
The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis.

UNIT II STATIONARY CRACK UNDER STATIC LOADING

UNIT III ENERGY BALANCE AND CRACK GROWTH

UNIT IV FATIGUE CRACK GROWTH CURVE

UNIT V ELEMENTS OF APPLIED FRACTURE MECHANICS
Examples of crack-growth Analysis for cyclic loading - leak before break – crack Initiation under large scale yielding – Thickness as a Design parameter – crack instability in Thermal or Residual – stress fields.

TOTAL : 45 PERIODS

TEXT BOOK:
REFERENCES:

ME2032 COMPUTATIONAL FLUID DYNAMICS L T P C
3 0 0 3

AIM
To impart the knowledge of numerical techniques to the solution of fluid dynamics and heat transfer problems.

OBJECTIVES
- To introduce Governing Equations of viscous fluid flows
- To introduce numerical modeling and its role in the field of fluid flow and heat transfer
- To enable the students to understand the various discretization methods, solution procedures and turbulence modeling.
- To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

PREREQUISITE:
Fundamental Knowledge of partial differential equations, Heat Transfer and Fluid Mechanics

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 8

UNIT II FINITE DIFFERENCE METHOD 9

UNIT III FINITE VOLUME METHOD (FVM) FOR DIFFUSION 9
Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank – Nicolson and fully implicit schemes.
UNIT IV    FINITE VOLUME METHOD FOR CONVECTION DIFFUSION      10
Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT V    CALCULATION FLOW FIELD BY FVM      9
Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-ε) models – High and low Reynolds number models.

TOTAL : 45 PERIODS

TEXT BOOKS:

REFERENCES:
5. Introduction to Computational Fluid Dynamics Anil W. Date Cambridge University Press, 2005.

I E 3401    DESIGN OF EXPERIMENTS      L T P C      3 1 0 4

OBJECTIVES
To impart knowledge on statistical tools for industrial experimentation related to selection of product and process parameters in various environments.

UNIT I  CONCEPTS AND TERMINOLOGY      5
Review of hypothesis testing – P Value, “t” Vs paired “t” test, simple comparative experiment, planning of experiment – steps. Terminology - factors, levels, variables, Design principles – replication, randomization, blocking, confounding, Analysis of variance, sum of squares, degrees of freedom.

UNIT II  SINGLE FACTOR EXPERIMENTS      10
Completely randomized design, Randomized block design, effect of coding the observations, Latin Square design, orthogonal contrasts, comparison of treatment means – Duncan’s multiple range test, Newman- Keuel’s test, Fisher’s LSD test, Tukey’s test.

UNIT III  FACTORIAL EXPERIMENTS      10
Main and interaction effects, Rules for sum of squares and expected mean square, two and three factor full factorial design, 2k designs with two and three factors, Yate’s algorithm, practical applications.
UNIT IV  SPECIAL EXPERIMENTAL DESIGNS  10
Blocking and confounding in 2k design, nested design, split – plot design, two level fractional factorial design, fitting regression models, introduction to response surface methods.

UNIT V  TAGUCHI TECHNIQUES  10
Introduction, Orthogonal designs, data analysis using ANOVA and response graph, parameter design – noise factors, objective functions (S/N ratios), multi-level factor OA designs, applications.

TOTAL : 45 +15 = 60 PERIODS

TEXT BOOK:
1. Dougus C. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, 2005

REFERENCES: