

# Curriculum

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## COURSE OUTLINES B.Sc. METALLURGICAL AND MATERIALS ENGINEERING

### FIRST SEMESTER

#### EE 199 Basic Electrical and Electronics Engineering 4(3,1)

##### Course Outlines:

**DC Machines:** Types of Excitation, Operation and characteristics of series, Shunt and compound generators and motors, Armature reaction, Stators, Selection of motors, Elementary transmission and distribution, DC and AC systems transmission voltages, Elements of house wiring: its testing, distribution, switching and fusing from the utilization point of view

**AC Circuits:** Series and parallel circuits and their combinations, Improvement of power factor by condensers, Three phase AC: advantages of single phase, Vector diagrams for the balanced three phase system, Earthing of apparatus.

**Transformers:** Basic principle, Ratio of transformation, Iron and Copper losses, Efficiency and regulation. Brief discussion and uses of instrument transformers and auto transformers, Three phase transformers, Star and delta connections, Scott connections, Constructional features, Cooling and protection from fire hazards.

**AC Generators:** Construction and working principles of alternator frequency, simple emf equation. Polyphase generation.

**AC Motors:** Concept of rotating field, polyphase induction motors, production of torque, slip, squirrel cage and slipring motors, starting of motors, construction of synchronous motors, production of torque and starting characteristics, selection of AC motors, measuring instruments, basic principles of construction and operation of moving iron dynamometer and hot wire instruments, power and energy meters, elementary consideration.

**Storage Batteries:** Lead and Nickel Iron cells, charge and discharge, quantity and energy efficiencies.

##### Lab Outlines:

Lab Manuals will be available in the concerned laboratory

##### Recommended Books:

Electricity: Principles and Applications by Richard Fowler. 8<sup>th</sup> ed. Mc-Graw Hill, (2012).

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## **ME 122L    Engineering Drawing    2(0,2)**

### **Course/Lab Outlines:**

Introduction, types of lines, lettering, dimensioning, use of pencil and drawing instruments, planning of drawing sheet

Projections, types of projections, orthographic projections, plane of projections, four quadrants, Isometric and pictorial projections of solids/machine parts

Making of freehand sketches from solid objects and from orthographic projections,

Sections of joints, screw thread systems, nuts and bolts, keys and cotter, coupling and simple bearings, pipe connections and engine details, preparation of assembly drawings.

### **Recommended Books:**

1. First Year Engineering Drawing by Albert Charles Parkinson.

## **MME 101 & MME 101L    Introduction to Metallurgy and Materials    4(3,1)**

### **Course Outlines:**

An introduction to the materials, classification of materials, structure-properties relationship, crystal structures and atomic packing factor. Grains and grain boundaries.

Introduction to mechanical properties of materials, hardness, tensile properties, compressive properties, creep, fatigue. Ductile to brittle transition.

Alloys and solid solution, Iron-allotropes and introduction to iron-iron carbide diagram

An introduction to welding and heat treatment methods.

Introduction to the mechanism of corrosion. Introduction to casting processes.

An introduction to metal working processes, Rolling, Forging, Extrusion. Introduction to powder metallurgy

Introduction to polymeric materials, distinguishing characters of polymeric materials, classification, mechanical properties (a brief introduction)

Introduction to ceramic materials, distinguishing characters, classification, mechanical properties

Introduction to composite materials, metal matrix composite, ceramic matrix composite, polymer matrix composite

Introduction to electric and magnetic materials

Introduction to nano, bio and advance materials

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## **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

## **Recommended Books:**

1. Fundamentals of Materials Science and Engineering by William D. Callister, David G. Rethwisch, An Integrated Approach. Wiley (2012)
2. Materials Science and Engineering: An Introduction by Callister. 8<sup>th</sup> ed. Wiley, (2009)
3. The Science and Engineering of Materials by Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright. 6th ed. (2010)
4. Foundations of Materials Science and Engineering by William Smith, Javad Hashemi. 5th ed. (2009)
5. Engineering Materials-I & -II by Ashby, M. F. and Jones, D.R.H. Butterworths- Heinemann, (2005)
6. Structure and Properties of Engineering Alloys by Smith, W. F. Mc Graw Hill, (2001)
7. Engineering Materials & Their Applications by Flinn, R. A. and Trojan, P. K. Houghton Mifflin, (2002)

Journals/Periodicals  
World Wide Web

## **IS 101 Islamic and Pakistan Studies-I 3(3,0)**

### **Course Outlines:**

**Part-I: Islamic Studies (60% of the total course)**

### **Qur'an and Sunnah**

#### **1) Al-Qur'an Al Karim**

a) Significance of The Holy Qur'an

Compilation of The Holy Qur'an

b) Textual Study of Surah *Al-Hujurat* (Complete): Meaning of the Arabic Text, Translation & Explanation

#### **Sura Al-Hujurat**

*Focus:* Impact of the teaching and commands mentioned in Sura *Al-Hujurat* on human life.

*Main Points of discussion:*

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- Command of Allah regarding meeting with the Holy Prophet peace be upon him
- Reports from wicked person to be tested
- Brotherhood, equality, efforts to compose the qurrel of groups and reconcile between them.
- Elimination of social evils such as to laugh at people in contempt, calling other by offensive nick names, suspicion and back biting.
- All people (mankind) are one and the most righteous gets most honor before Allah.
- Qualities of believers
- Knowledge of Allah about the secrets of the heavens and the earth and our actions

## Sura Al-Maida

c) Textual study of Surah *Al-Maida* (Verses: 1-26): Meaning of Arabic Text, Translation & Explanation

*Focus:* Impact of the teaching and commands mentioned in Sura *Al-Maida* on human life.

### *Main Points of discussion:*

- Stress on fulfillment of uqud (obligations)
- Concept of Halal (lawful) and Haram (forbidden) in Islam
- Halal and Haram animals and food
- Symbols of Allah
- Emphasis on Helping one another on righteousness and piety
- Rules for hunting the animals for food
- Social relationship with non muslims
- Relationship between Muslims and *Ah'l Al-Kitab* (people of the book)
- Rules of purity and cleanliness
- Allah's command to do justice and act righteously
- The convent of Bani-Israel (The children of Israel) with Allah and breach of their convent
- Allah's address to *Ah'l Al-Kitab*
- Address of prophet Moses (peace be upon him) to his peaple

d) Textual Study of Surah *Al-Fur'qan* (verses: 63 to 77): Meaning of Arabic Text, Translation & Explanation

*Focus:* Impact of the teaching and commands mentioned in Sura *Al-Fur'qan* on human life.

### *Main Points of discussion:*

- Characteristics of *Ibad-ur-Rehman* (slave of Allah)

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## 2) Al-Hadith Al-Sharif

- a) The need & Importance of Hadith
- b) Textual study of Hadith (*Arbaeen-e-Navavi by Imam Nawai*), *Hadith: 1 to 21* (Meaning of Arabic Text, Translations and explanation.)

*Focus:* Impact of the teaching and commands mentioned in Ahadith on human life.

*Main Points of discussion:*

- Importance of intention (Niyya) in human actions
- Islam, Iman (belief), Ihsan (excellence) and the Hour
- Rejection of Innovation (Al-Bidah) in religion (Din)
- Lawful, unlawful and doubtful matters
- Sincerity to Allah, His Books, His Messengers, Leaders of Muslims and common people
- Protection of lives and property of people
- Obedience of the Holy Prophet (peace be upon him)
- Importance of lawful food, drink, clothing and nourishing
- True believer is who likes for his brother that he likes for himself
- Honor of the blood of Muslims and others
- Respect of neighbors and guests
- Importance of good talk and silence
- Prohibition to become angry and furious Ihsan with regard to everything
- Good behavior towards people
- All kinds of expectation, help and benefit from Allah
- Importance of Modesty (Al-Hiya)
- To stand firm on Islam

## 3) Den-e-Islam, The study of basic articles of faith

*Focus:* Impact of basic articles of Faith on human life.

*Main Points of discussion:*

- a) *Tawheed:* Fundamentals and types of *Tawheed*,
- b) Prophet-hood and Finality of Prophet-hood,
- c) The Day of Judgment

## 4) Seera-tun-Nabi

Life of The Holy Prophet (Peace be upon him) from prophet-hood to *Hijrah*

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*Focus:* Impact of the study of the life of Holy Prophet (peace be upon him) on human life.

*Main Points of discussion:*

- First revelation
- Message of the Holy Prophet (peace be upon him) to the people
- Difficulties in preaching Islam in Makkah and opposition of Quresh
- Reason of Hijra (migration) to Madina and impact of his migration

## 5) Islam and Modern Science

*Focus:* Impact of the teaching regarding Modern Science on human life.

*Main Points of discussion:*

- a) The Holy Qur'an as a guide for the modern scientific development, Surah *Al-Baqra*: verse 164, *Aal-e-Imran*: verses 190-191
- b) Importance of science education in the modern age
- c) Introduction of Muslim scientists, contribution of Muslim Scholars towards science

## 6) Ethics

*Focus:* Impact of ethics on human life.

Definition, importance and significance of Ethics

Concept of Ethics in the light of Holy Qur'an

<i>Al-Baqra</i>	verses	83, 169
<i>Al-Ana'am</i>	verses	151,152,153
<i>Al-Tauba</i>	verse	7
<i>Yunus</i>	verse	36
<i>Hood</i>	verse	18
<i>Al-Nah'l</i>	verse	112
<i>Al-Mutafffeen</i>	verses	1,2,3

*Main Points of discussion:*

- Kindness with parents, kindred, orphans and needy people
- Fair speaking to the people
- Refrain from evil and shameful deeds
- Abstain from killing any person except by the way of law
- Security of Orphan's property

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- Full justice in measure and weight
- Prevention from inventing a lie
- Fraud and its bad effects

*Moral values in the light of Hadith:*

Bulugh-ul-Maram, Kitab-ul-Jamae, Babul Tarheeb Min  
Msavi-al-Akhlaq

*Ahadith* No.3, 4,7,14,17

*Main Points of discussion:*

- To control anger
- Oppression is darkness
- Telling a lie is a sign of hypocrisy
- backbiting

*Ethics and character building in the light of Seerah:*

Ethical behavior of the Holy Prophet (PBUH)

Significance of moral values

- i) Truth, (ii) Honesty, (iii) *Taqwa*, (iv) Brotherhood,  
(v) Patience

*Comparative Religious Morals:*

- (i) Hinduism, (ii) Buddhism, (iii) Judaism, (iv) Christianity,  
(v) Islam

Philosophy of Ethics in revealed and non-revealed religions  
(An Analysis)

## **Part-II: Pakistan Studies, 40% of the total course**

### **1. Ideology of Pakistan**

- i) Definition & Explanation.
- ii) Aims & objects of Formation of Pakistan.
- iii) Ideology of Pakistan in the light of the sayings and speeches of Allama Iqbal and Quaid-e-Azam

### **2. A Brief History of Muslim Society in Subcontinent**

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- i) The arrival of Muhammad Bin Qasim.
- ii) The Afghan invasions from North.
- iii) The Domination of Islam in Sub-Continent.
- iv) The down fall of Muslim Rules and renaissance of Muslim rule in Sub-Continent.

### **3. Historical back ground of the Ideology of Pakistan, National & Reformative Movements.**

- i) Sheikh Mujaddad Alf-I-Sani.
- ii) Shah Wali Ullah.
- iii) Mujahiddeen Movement.

#### **i) Sheikh Mujaddad Alf-I-Sani**

- Biography, Social & Religious Services
- Efforts against non Islamic Fundamentals.
- Effects of the Movement.

#### **ii) Shah Wali Ullah**

- Biography
- Efforts Against non-Islamic fundamentals.
- Reforms, social and religious services.

#### **iii) Sayyed Ahmad Shaheed**

- Biography
- efforts against sikhs,
- opposition from Afghan tribes.
- Martyrdom at Balakot.

### **4. Educational Efforts**

- Services of Sir Syed Ahmad Khan (Ali Garh Movement)
- Political Aspects of Aligarh movement
- Educational services of Aligarh movement
- Impact of Aligarh movement

### **5. Pakistan Movement**

- Muslim Nationalism
- Evolution of Two-Nation Theory



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- Independence of India & Muslims
- Khilafat Movement and Non-Cooperation movement
- Role of Ali Brothers and Mr. Gandhi
- Presidential Address of Allama Iqbal at Allah Abad in 1930
- 1937 Elections. Congress behavior. Pakistan Resolution.
- 1946 Elections and transfer of power
- How to safeguard the ideological state in present era

## **MA 111 Applied Mathematics-I 3(3,0)**

### **Pre-requisites:**

Derivative of a function; Differentiation; Rules of differentiation; Differentiation of algebraic, trigonometric, inverse trigonometric, exponential and logarithmic functions; Differentiation of implicit functions; Increasing and decreasing functions; Maxima and minima of a function. Anti-derivatives; Integration; Basic techniques of integration; The definite integral. Algebra of complex numbers; polar form of complex numbers; Algebra of vectors; Scalar and vector products; Algebra of matrices; Determinants and their properties; Cramer's rule.

### **Course Outlines:**

A review of differentiation; Geometrical interpretation of a derivative; Infinitesimal; Differential coefficient; Derivatives of higher order; Indeterminate forms and L. Hopital's rule; Asymptotes; Curvature; Approximation and error estimates.

The concept of limit, continuity and differentiation in functions of several variables; Geometric interpretation of partial derivatives; Total differential; Chain rule; Implicit differentiation; Maxima and minima of functions of two independent variables.

Further techniques of Integration; Integration by reduction formula; Fundamental Theorem of Integral Calculus; Properties of definite integrals; Area enclosed between curves; Arc length; Volume of a solid; Volume of a solid of revolution; Area of surface of revolution; Moments; Centroids.

Cartesian, cylindrical and spherical coordinates; The ratio formula; Equations of a straight line in  $R^3$ ; Direction ratios and direction cosines; Angle between two straight lines, Distance of a point from a line; Equations of a plane; Angle between two planes; The sphere; Vector triple products. Differentiation and integration of vectors; Directional derivatives.

Product and quotient of complex numbers in polar form; Properties of complex numbers; Logarithm of a complex number; De Moivre's Theorem, The  $n$ th roots of a number; Solution of equations; Circular and hyperbolic functions. Analytic functions.

A review of matrices, determinants and finding inverse of a matrix through elementary row operations; Solution of the system of linear equations; Eigenvalues and eigenvectors.

## Curriculum

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Motion along a straight line with uniform acceleration, motion along a curved path. Tangential and normal components of acceleration.

### **Recommended Books:**

1. Mathematics for Engineers and Scientists by Muhammad Iqbal Bhatti and Muhammad Nasir Ch. Published by Allied Book Centre, Urdu Bazar Lahore.
  2. Calculus by Thomas and Finny. Addison Wesley
  3. Advanced Engineering Mathematics by E. Kreyszig. John Wiley & Sons
  4. Calculus by Howard Anton.
  5. Calculus by Swokowski.
  6. Introduction to Mechanics by Q.K Ghori. Published by Ilmi Kitab Khana, Urdu Bazar, Lahore.
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## **SECOND SEMESTER**

### **PHY 114 Applied Physics 3(2,1)**

#### **Course Outlines:**

##### ***Introduction***

System of absolute units, CGS units, practical units, relationship between electrical, mechanical and thermal units

##### ***Waves***

Waves and oscillations, wavelength and frequency, interference of waves and the resulting amplitude

##### ***Electricity and Magnetism***

Magnetic effects of current, relationship between electricity and magnetism, electro-magnetic induction, induction-heating and effect of frequency, magnetic materials, B-H curves, hysteresis, soft and hard magnets

##### ***Atomic and Nuclear Physics***

Atomic and nuclear physics, isotopes, radio-activity, fission and fusion

##### ***Modern Physics and Electronics***

Introduction to quantum - mechanics, electrical conduction through metals, electron-emission, thermionic-emission, field-emission, secondary-emission, photoelectric-emission, photocells and photo-multiplier tubes, semi-conductors, basics of insulators and dielectrics, plasma Physics

#### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

#### **Recommended Books:**

1. Fundamental of Physics by David Halliday, Robert Resnick, and Jearl Walker. 10<sup>th</sup> ed. Extended edition (2015)
2. Applied Physics (University Physics) by Sears, Zemansky and Young. 7<sup>th</sup> ed.
3. Physics for scientist and Engineers with Modern Physics by Douglas C. Giancol. 4<sup>th</sup> ed.

### **CY 151 Material Chemistry-I 3(2,1)**

#### **Course Outlines:**

Introduction to chemistry, its scope and importance in Metallurgy and Materials Engineering.

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Classification of elements, periodic table and electronic configuration. State of matter (gas, liquid, solid) kinetic theory of gases, solutions. Basic laws: Rault's law, Henry's law, Sievert's law, Law of diffusion.

Theory of crystallization, atomic bonding, crystal systems, properties of solid, liquid and gases. Chemical equilibrium: Chemical reaction and equilibrium, chemical kinetics, theory of electro-chemistry, heterogeneous equilibrium, phase-rule, quantum theory.

Introduction to oxidation and reduction reactions in iron and steel making, Oxygen potential diagrams.

Organic chemistry: Introduction, nature and sources of compounds, hydrocarbon compounds, chemistry of hydrocarbon compound cracking, introduction to biochemistry.

Analytical chemistry: Introduction, qualitative and quantitative analysis of ferrous and non-ferrous metals, analysis of various ores, coals, liquid solution, introduction to analytical instrumentation

## **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

## **Recommended Books:**

1. Chemistry for Engineer by Shultz. 1<sup>st</sup> ed. Brookes Cole, (2006).
2. Materials Chemistry by Fahlman. 2<sup>nd</sup> ed. Springer, (2011).
3. Applied Chemistry by Hyman D. Gasser. Springer, (2002)
4. Applied Chemistry by Edward Andrew Parnell. D. Appleton & Co., (2007)
5. Chemistry by Thodore E. Brown. Prentice Hall, (2005)
6. Industrial Chemistry by M. Farhat. McGraw-Hill, (2004)

## **ME 100L Workshop Practice 1(0,1)**

### **Course/Lab Outlines:**

**1. Machine Shop:** Detailed study of centre lathe and accessories. Plain and Taper turning. Basic lath operations including turning, facing, simple screw cutting/treading, knurling, Grooving (Drilling and Boring), cutting tools and their grinding. Brief Introduction of shaper, milling Shaping and Surface Grinding Machine. Assigning of Practical Jobs.

**2. Fitting and Fabrication Shop:** The use and care of fitter's tools. Marking out of job. Practice in Metal filing. Sawing, Drilling, dieing, Tapping and reaming. Brief introduction and use of power Hack Saw, Arbor Press, Sheet Shaping Machine, Sheet Rolling Machine, Punching Machine and Drilling Machine. Assigning of practical Jobs.

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**3. Carpentry Shop:** The use and care of tools. Type of Timber, its defects and preservation methods practice in planning and sawing. Different types of wood joints. Study of sawing, planning, turning mortise and tenon machines. Assigning of Practical Jobs.

**4. Electrical Shop:** Electric shocks and treatment. The use and care of tools used by Electrician. Types and uses of cable and electrical accessories for house wiring, practice in simple house wiring, testing methods. Switch gear used on domestic installation and DB system. Earthing System. Assigning of Wiring arrangements practical.

### **Recommended Books:**

1. Workshop Technology part-1 by W.A.J Chapman.
2. Electrical Wring by Richter and Schwan
3. Wiring Manual by Pak Cables Limited.

## **HU 111 Communication Skills 1(0,1)**

### **Course Description:**

This is a practical course which offers an opportunity to learn, apply and practice principles of interpersonal communication in daily life. Emphasis is placed on psychological, social, cultural and linguistic factors which affect both interpersonal and inter-organizational dealings.

### **Methodology:**

The following methodology will be used to attain the overall course objectives.

1. Group discussions
2. Case studies
3. Presentations
4. A/V aids
5. Audio/video clips
6. Pair works
7. Handouts
8. Home assignments
9. Quizzes

### **Recommended Books:**

1. Effective Business Communicatrion by Murphy, Hildebrandt and Thomas. 7<sup>th</sup> Edition

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2. Basic Communication Skills for Technology by A.J. Rutherford. 2<sup>nd</sup> Edition
3. Basic Business Communication by Lasiker. 8<sup>th</sup> Edition
4. A practical English Grammar by Thomas and Martinet
5. English for Undergraduates by Howe and Kirkpatrick.

## **MME 102 Mechanics of Materials 2(2,0)**

### **Course Outlines:**

Stresses and strains, Hook's law, tensile-test and its interpretation, temperature stresses, bending moment and shear force diagrams for determinate beams, principle of super-position, relationship between loads, shear force and bending moment.

Columns: type of columns, different formulae of critical load.

Trusses: types and calculations

Torsion of circular section

Strain energy due to direct load, shear, bending and torsion, impact loads

Calculations of stresses in pressure-vessels, power-transmission shafts, gears, solid and hollow shafts

### **Recommended Books:**

1. Mechanics of Materials by Beer and Johnston. 7<sup>th</sup> ed. McGraw Hill Inc., (2014)
2. Mechanics of Materials by J.M. Gere and B.J. Goodno. 7<sup>th</sup> ed. (SI edition). CL Engineering, (2008)
3. Strength of Materials by Andrew Pytel and Ferdinand Leon Singer. 4<sup>th</sup> ed. Harper International, (1990)

Journals/Periodicals  
World Wide Web

## **MA 112 Applied Mathematics-II 3(3,0)**

### **Pre-requisites:**

Techniques of differentiation and integration (Applied Mathematics-I)

### **Course Outlines:**

Double integration; Fubini's Theorems; Change of order; Geometrical Interpretation of double integral; Applications to find volumes and areas.

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Formation of differential equations; Solution of various types of first order differential equations; Orthogonal trajectories, Application in physical problems; Linear differential equations of second order; Complementary function and particular integral; Methods of undetermined coefficients and variation of parameters.

Formation of partial differential equations; Equations reducible to ordinary differential equations; Equations of the form  $Pp + Qq = R$ ; Solution by the method of separation of variables. Wave, heat and Laplace equations.

Laplace transforms of elementary functions. Basic properties. Inverse transform. Application in solution of initial value problems. Convolution theorem.

Periodic functions. Even and odd functions. Fourier series of functions of period  $2\pi$ . Arbitrary period, half range series.

## **Recommended Books:**

1. Mathematics for Engineers and Scientists by Muhammad Nasir Ch. and Muhammad Iqbal Bhatti. Published by Allied Book Centre, Urdu Bazar Lahore.
2. Advanced Engineering Mathematics by E. Kreyszig. John Wiley & Sons,
3. Calculus by Thomas & Finny. Addison Wesley
4. Calculus by Howard Anton.
5. Calculus by Swokowski.
6. Ordinary Differential Equations by N.A. Shah. A-one publishers, Urdu Bazar, Lahore.

## **MME 103 Industrial Safety and Environmental Engineering 3(3,0)**

### **Course Outlines:**

Industrial safety management, Understanding accident and hazard, Hazard control and loss control. Accident Prevention and Control, Accident reporting and investigation, Fire safety, Electrical Safety, Safety in boilers, Safety in material handling and storage, Safety in production operations. Process Safety Management: Development of facility operation and procedures, Analysis of process hazard. Hazard communication, Chemical inventory record. Industrial Hygiene and Workers Protection, Various hazards encountered in workplace, Types of personal protective equipment (PPE), Availability in market their design standards and selection criteria. Environment Management: Environment pollution, Air emission management, Waste management, Waste water treatment and control, Soil and ground water protection, Introduction to Pakistan Environment Protection Act 1997 and National Environmental Quality Standards, Key elements of ISO 14000.

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## **Recommended Books:**

1. Occupational Safety & Health Management by Thomas J. Anton. 2nd ed., McGraw Hill, (2006)
2. Safety and Environmental Management by Daniel E. Della-Giustina. (2001)
3. A Guide to Industrial Safety and Health by Ronald Packman. Longmans, (2007)
4. Occupational Safety by James S. Angle. Thomson Delmar Learning, (2004)

Journals/Periodicals

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## **THIRD SEMESTER**

### **MME 201 Fuels and Furnaces 2(2,0)**

#### **Course Outlines:**

Introduction: Fuels and their classification, Conventional and newer sources of energy.

Characterization of fuels: Proximate and ultimate analysis of coal, Calculation of calorific value of solid, liquid and gaseous fuels. Flash Point, Fire Point, Cloud Point, Pour Point, Viscosity measurement methods for liquid fuels.

Principles of Conversion of Solid Fuels: Carbonization of coal for manufacturing of coke, Gasification and hydrogenation of coal.

Furnaces: Types of furnaces and their role in high temperature applications, Refractories and their role in furnaces. Heat transfer in furnaces: Conduction, convection and radiation.

Calculations for fuel combustion and its utilization: Combustion and combustion calculations, flame temperature and its calculation, effect of various variables on flame temperature. Concept and calculation of gross available heat, Factors affecting fuel utilization in furnaces, Heat recovery techniques for furnaces, recuperators and regenerators, Sankey diagram with illustrations.

Burner Design: Types and design of burners for liquid and gaseous fuels.

Environmental considerations: Environment considerations of fuel combustion, Environment friendly fuel resources.

#### **Recommended Books:**

1. Elements of Fuels, Furnaces and Refractories by O.P Gupta. 6<sup>th</sup> ed. Khana Publishers, (2014)
2. Industrial and Process Furnaces by P.Mullinger and B. Jenkins. Elsevier, (2008)
3. Metallurgical Problems by Allison Butts. Jhonston Press, (2007)
4. Fuel and Energy, by Harker and Backhurst. Academic Press, (1981)

Journals/Periodicals  
World Wide Web

### **MME 210 & MME 210L Foundry Engineering 4(3,1)**

#### **Course Outlines:**

Introduction of Foundry Engineering, Different Sections of a Foundry

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Classification of Casting Processes (Sand casting processes, Carbon dioxide process, Plaster casting, Investment casting, LPDC, HPDC, Permanent mold casting, Centrifugal casting, Slush casting, Ingot as casting)

Mold materials (sands, types of sands, clays, types of clay minerals & their design for ingots), Nonferrous metal ingots

Sand casting process: parts of mold (riser, runner, sprue, gate, choke, sprue base, chaplets, cores, pouring cup, vents, flasks, patterns), classifications of sands on the basis of size & shape, influence of sand grain size on permeability of sands, bonding of clays (electrostatic interactions, surface tension theory, block & wedge theory), properties of sands (dry strength, green strength, hot strength, flow ability, plasticity, permeability, collapsibility), molding sand binders, Clays, molding sand additives, Sand Testing

Patterns, Pattern allowance, Pattern Materials, Factors affecting selection of patterns,

Cores (types of materials for cores, functions, core making, core baking, core removal), finishing of cores (cleaning, sizing, core assembly & inspection) types of core ovens, core sand ingredients, core binders (organic, inorganic), Core molding, core coatings, (refractory filler, liquid carriers, binders, rheological control agents), core sand properties, testing of core sands (green strength, baked strength, warm strength, standard AFS test core, hot strength, retained strength, permeability, core hardness), core defects

Casting defects and remedies

## **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

## **Recommended Books:**

1. Complete Casting Handbook for Metal casting processes, techniques and design by Jhon Cambell. Butterworth Heinmann, (2011)
2. Principles of metal casting by Richard W Heine, Carl R Looper, Philip C Rosenthal, 2<sup>nd</sup> ed. (reprinted) – Tata McGraw-Hill, (2008)
3. Casting by John Cambell. 2<sup>nd</sup> ed. Elsevier, (2004)
4. Principles of Foundry Technology by P L Jain. 8<sup>th</sup> ed. Tata McGraw-Hill, (2008)
5. Manufacturing processes – II by H S Bawa. 1<sup>st</sup> ed. Tata McGraw-Hill, (2006)

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World Wide Web

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## **IS 201 Islamic and Pakistan Studies-II 3(3,0)**

### **Course Outlines:**

#### **Part-I: Islamic Studies (60% of the total course)**

##### **1) Al-Qur'an Al Karim**

1. Miracles (*Ijaz*) of the Holy Qur'an
2. Principle of interpretation (*Tafseer*)
3. Textual Study of the Holy Qur'an.

Surah Luqman (complete): Meaning of Arabic text, Translation & Explanation

*Focus*: Impact of the teaching and commands mentioned in Sura *Luqman* on human life.

*Main Points of discussion*:

- Characteristics of the righteous people (Al-Mohsineen) and their reward
- Explanation of *Lah wal hadith* and torment of its buyer
- Universal logical argument on Allah as the creator
- Conquering the Universe
- Advices of Luqman to his son: not to associate anyone with Allah, to establish Salat, enjoin good, forbid evil, bear the difficulties, not to speak to others with your face turned away, not to walk proudly and lower your voice
- Orders of Allah to recognize the rights of parents
- *Amr Bil Maruf and Nahi Anil Munkar*, Need, Importance and methods of preaching, Characteristics of a preacher
- Allah has subjected to man everything in the earth and the heavens and bestowed on him His all favors
- Punishment for a disbeliever
- Stress on fear of Allah the Lord and the judgment day
- Knowledge of Allah

##### Surah Al-Noor:

*With Al-Baqra*: 178, 179, *Al-Nisa*: 92,93, *Al-Maidah*: 8, 31-34,38,  
*Al-Noor*: 2-6, 27-29, 31,60, *Al- Ahzab*: 32,33,53,55,59 (subjective study of the surah.

*Focus*: Impact of the teaching and commands mentioned in Sura *Al-Noor* on human life.

*Main Points of discussion*:

- Introduction to criminal law of Islam, concept of crime and punishment
- Classification of crimes in Islamic Criminal Law: *Hudood and Tazirat*

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- *Hudood Zina (adultery, fornication)*
- *Qad'f (false accusation)*
- *Li'an (Accusation of a wife of zina)*
- Drinking intoxicating liquors, narcotics
- Theft, dacoity, robbery, Murder, Apostasy and Rebellion
- *If'k story (slander)*
- Privacy, *Hijab* (Woman's veil)

## 2) *Al-Hadith Al-Sharif*

1. Compilation of Hadith.
2. A Brief Introduction of *Sihah Settah* and its compilers.
3. Textual study of Hadith:

*Bulugh-ul-Maram. Kitab-ul-Jami (Bab-ul-Adab, Bab-ul-Bir Wa Selah)* (Meaning of Arabic text, translation and explanation)

*Focus:* Impact of the teaching and commands mentioned in Ahadith on human life.

*Main Points of discussion:*

- Obligation on a Muslim for a Muslim
- Golden principle to lead a satisfied life and to control one's greed
- What is righteous? and What is sin?
- Emphasis on the respect of human sentiments
- Social manners
- awareness of a meal blessed with auspiciousness
- manners of salaam and greetings with Muslims and non-Muslims
- manners regarding sneeze, eating, drinking, wearing clothes, putting on and off shoes and walking with shoes
- restriction of trailing garments arrogantly
- restriction of overspending

*Bab-ul-Bir Wa Sila:* (Kindness and joining the ties of relationship)

- Golden principle of expansion of one's provision and increase in life span
- Prohibition to sever ties of relationship
- Unlawful to be undutiful to Mothers, to bury daughters alive, to refuse others and to demand from others
- Hatred actions
- Pleasure and displeasure of Allah result from pleasure and displeasure of parents
- Rights of neighbors
- Most serious sin

# Curriculum

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- Prohibition of reviling parents
- Prohibition of Muslim to avoid his brother
- Importance of any minor act of goodness
- Importance of help provided for others
- Reward of concealing the faults of others
- Re-compensation of kindness from others

### 3) Deen-e-Islam

#### **Pillars of Islam: *Shahada, Salat, saum, zakat, Hajj, Jihad***

*Focus: Impact of Shahada, Salat, saum, zakat, Hajj, Jihad on human life.*

*Main Points of discussion:*

- **Shahada**(Witness): Importance and philosophy of witness that no God but Allah and Muhammad (peace be upon him) is His messenger
- **Salat** (Prayer) (Imposition of Prayer, Orders, Shariah's point of view about Significance).
- **Saum** (Fasting) Meaning of Fasting obligation of Fasting, significance, disbursement, physical and spiritual advantages)
- **Zakat**: The Economic system of Islam, Importance of *Zakat*, Prohibition of *Riba* (Interest). Comparison between Islamic Economic system and socialism, Capitalism & Communism,
- **Hajj**: (Imposition of Hajj, commands and rites of *Hajj*, financial social and spiritual advantages of *Hajj*)
- **Jihad**: Importance and significance, Necessity of Jihad in Modern age, Kinds of *Jihad*
  - Against one's soul: to control its ego and desires (The greatest Jihad)
  - Against ignorance
  - Against Satan
  - Against enemy
  - against disbelievers by the Holy Qur'an etc.

### 4. Seerah-Tun-Nabi

*Focus: Impact of the life of Holy Prophet (peace be upon him) on human life.*

*Main Points of discussion:*

- Life of the Holy Prophet (Peace be upon him) at Madina, Madina Pact
- The Holy Prophet (Peace be upon him) as a Perfect Man,
- Mohammedan Revolution.

# Curriculum

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## 5. Ethics

*Focus:* Impact of *Ethics* on human life.

*Main Points of discussion:*

### **(1) Ethics and Religion**

Ethical behavior of the Prophets

- i. Impact of belief on Ethics.
- ii. Concept of worship and manners/ social relations in religion and their impact on ethics

### **(2) Ethics and character building, significance of moral values**

- i. Charity, Tolerance, Simplicity, Respect of mankind
- ii. Social Etiquettes of meetings, eating & drinking and conversation, Right of people.

### **Verses of the Holy Qur'an about Ethics**

*Aal-e-Imran:* verse 112

*Al-Nisa:* verses 43, 90, 91

*Al-Aa 'raf:* verse 35

*Al-Ra 'd:* verse 30

*Al-Nah 'l:* verses 90, 91

*Ban iSrail:* verses 29-37

*Al-Fat 'h:* verse 26

*Main Points of discussion:*

- Purity and cleanliness
- Nourishing of peace
- Liberality to kith and kin
- Fulfillment of contracts
- Condemnation of misery
- Negligence from the signs of Allah
- Trust in Allah

### **Moral values in the light of Hadith:**

*Bulugh-ul-Maram, Babul Zoh 'd wal Wara',* Ahadith 2,6

*Babul Tarheeb Mm Msavi Al-A khlaq:* Ahadith No.1,6,9

*Main Points of discussion:*

- Misery

# Curriculum

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- Worldly desires
- Avoid envy
- Showing good deeds
- Insulting and abusing others

## **Part-II: Pakistan Studies, 40% of the total course**

### **Formation of Pakistan**

- Role of Scholars & Mashaikh, Students and Women, Journalists and Adeebis in the formation of Pakistan.
- Contribution of Non-Muslim leaders in the struggle of Pakistan
- Initial Difficulties after Formation of Pakistan
- Anti-Muslim riots in India, Massacre in East Punjab,
- Canal Water and distribution of Assets,
- Accession of States: Hyderabad, Junagarh & Kashmir, its background and danger for the peace of South Asia.

### **The Land of Pakistan**

- Geographical importance
- Pak-China economic corridor
- Agriculture and industrial resources
- Man power and education

### **Efforts for Execution of Islamic System in Pakistan**

- Objectives Resolution 1949
- Islamic clauses of the Constitutions of 1956, 1962, 1973.
- Process of Islamization during Zia era.

### **Foreign Policy of Pakistan**

- Determinants and Principles of Pakistan foreign policy
- Importance of Pakistan in Islamic World
- Pakistan and International Organizations: UN, OIC, SAARC, ECO and SCO
- Economical and defensive planning (Nuclear policy)

# Curriculum

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## **MA 240 Numerical Analysis 3(2,1)**

### **Course Outlines:**

Basic concepts: round-off errors, floating point arithmetic, Convergence.

Solution of non-linear equations: Simple iterations; Bisection method; Newton's method; Secant method; Method of false position.

Solution of linear simultaneous equations: Jacobi's method; Gauss-Seidle method;

Finite differences: Difference operators and tables; Newton's interpolating techniques for equally spaced data; Newton divided difference table and interpolation; Lagrange's formulation of interpolation.

Numerical differentiation: approximating the derivative.

Numerical integration: Review of integration concept and their physical significance for engineering; Trapezoidal and Simpson's rules.

Solution of differential equations: Euler's methods; Runge Kutta methods.

Computations: Numerical techniques in context of engineering applications and solutions of problems by using Matlab.

### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

### **Recommended Books:**

1. Numerical Methods for Engineers by S. C Chapra & R. P Canale, McGraw-Hill.
2. Numerical Methods using MATLAB by John H. Mathews, Pearson Education.
3. Applied Numerical Methods for Engineers using MATLAB by Robert J. Schilling & Sandra L. Harris, Brooks/Cole.
4. Numerical Methods for Engineers and Scientists by D. Joe Hoffman.
5. A First Course in Numerical Analysis with FORTRAN and C. by Saeed Akhtar Bhatti.

## **HU 221 Technical Writing & Presentation Skills 3(3,0)**

### **Course Description:**

This course has been designed to teach students to adapt their writing to different audiences and purposes. It will help learners to develop strategies for making subjects clear to readers who need to understand



# Curriculum

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them. Through this course, learners will learn to write in a clear, concise style and to present information logically, and to design documents in which format contributes to clarity and efficiency.

## **Methodology:**

Teaching of concepts shall take place through lectures, during which analysis of technical examples will help students to grasp the concepts being taught. Exercises will follow each new concept: in order to check and reinforce understanding.

## **Recommended Books:**

1. Technical Communication. A Reader-Centered Approach by Anderson. V. Paul. 5<sup>th</sup> ed. Thomas Wadsworth, (2003)
2. Technical Writing. Process and Product by Gerson & Gerson. 5<sup>th</sup> ed. Pearson Education Inc., (2006)
3. English for Science and Technology by Huckin & Olsen. McGraw-Hill Inc., (1983)
4. Power Tools for Technical Communication by McMurrey. D. Wadsworth Publishing Company (2001)

## **MME 202 Applied Thermodynamics 3(3,0)**

### **Course Outlines:**

Introduction to Metallurgical Thermodynamics, concept of system and surroundings, extensive and intensive properties

First Law of Thermodynamics, concept of Enthalpy, calculation of heat of reactions, concept of heat capacity and its variation with temperature, Kirchoff's equation and its applications in the calculation of heat of reaction at high temperatures.

Concept of Entropy, Second Law of thermodynamics, Third law of thermodynamics, calculation of entropy of elements and reactions at various temperatures

Free-energy, and the concept of driving-force behind a chemical or physical reaction, Free energy of mixing

Equilibrium constant, Le-Chatlier's Principle, Factors affecting the equilibrium position Relationship of equilibrium constant with free energy, Calculations of equilibrium partial pressures. Ellingham diagrams and their application to commercially important reactions

Behavior of solutions, concept of activity, ideal and non-ideal solutions, Raoult's and Henry's Law, Gibbs Phase Rule, Clausius Clapeyron Equation, Concept of diffusion

### **Recommended Books:**

## Curriculum

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1. An introduction to Chemical Metallurgy by R. H. Parker. 2<sup>nd</sup> ed. Elsevier, (2013)
2. Material Thermodynamics by Y. Austin Chang, W. Alan Oates. 1<sup>st</sup> ed. Wiley, (2009)
3. Introduction to Thermodynamics of Materials by David R. Gaskell. 5<sup>th</sup> ed. Taylor and Francis, (2008)
4. Principles of Thermodynamics by Kaufman M. CRC Press, (2002)
5. Chemical Metallurgy by John Jeremy Moore and E. A. Boyce. 2<sup>nd</sup> ed. Butterworth Heinmann, (1994)
6. Phase Transformation in Metals and Alloys by D.A. Porter and K.E. Easterling. 2<sup>nd</sup> ed. Chapman and Hall, (1992)

Journals/Periodicals  
World Wide Web

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# Curriculum

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## **FOURTH SEMESTER**

### **MME 211 & MME 211L Physical Metallurgy 4(3,1)**

#### **Course Outlines:**

Introduction to different types of materials. Historical perspective of materials. Structure properties relationship. Structures at different scales.

Atomic structure: Quantum theory of atomic structure.

Chemical bonding: Different types of chemical bonding

Crystalline structure / Crystallography: Space lattice, Unit cell, Bravais and primitive cells, Short and long range order, Crystal symmetry (rotational and reflection symmetries), Different types of crystal structures, Coordination-number, Planes and stacking of crystal-planes, Crystalline defects, Twinning, allotropy and polymorphism, Theoretical density, Atomic packing density, Indexing crystal planes and directions, Interplanar spacing, Angle between crystallographic directions, Linear and planar densities, Free energy of planes, Volumetric density, Voids in crystalline structures, Solid solubility – solubility of C, N and H in Fe, Prediction of ceramics crystalline structures. An introduction to structure of polymeric and composite materials, Structure of semiconductors and theory of conduction and valence bands, An introduction to nano-Materials.

Crystallization: Solidification, Homogeneous and heterogeneous solidification, critical radius of nuclei and undercooling, Grain-boundaries, Grain-size, Single and Poly-crystals, Cast structures, Segregation, Porosity and shrinkage defects, Continuous Casting vs conventional ingot casting.

Metallurgical microscope: Optics of convex and concave lenses, Metallurgical vs Biological microscope, Light vs electron microscope, Principle of image formation of a light microscope, Different parts of a light microscope, Magnification of microscope, Functions of eye piece and objective lenses, Resolution, Different factors affecting the resolution, Shortcomings of objective lens, Metallographic techniques, use of polarized light, Theory of etching, Concepts of surface energy, Etching of single and poly-phase materials, Defects of etching.

Binary Phase diagrams: Phase-rule, Solid solutions, Interstitial and substitutional solid solutions, Factors affecting the limits of solubility, Types of Compounds, Different types of binary phase diagrams, Eutectic and eutectoid reactions with examples, Precipitation hardening (coherent, semi-coherent and in-coherent precipitates) with examples, Congruent melting intermediate phases, Peritectic and peritectoid reactions with examples, Ordered and disordered solutions, Ternary systems.

Iron-Iron carbide binary phase diagram, Microstructure development and properties of different types of plain carbon steels, and cast-irons, Microstructure of common copper-base and aluminum-base alloys, and their microstructure-properties relationship.

# Curriculum

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## **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

## **Recommended Books:**

1. Physical Metallurgy by William F. Hosford. 2<sup>nd</sup> ed. CRC Press, (2010)
2. Physical Metallurgy Principles by Reza Abbaschian, Robert E. Reed-Hill –SI Version 4<sup>th</sup> ed. CL Engineering, (2009)
3. Physical Metallurgy Principles by Reed Hill, R. E. and Abbaschian, R, 3<sup>rd</sup> ed. PWS, (2008)
4. Introduction to Physical Metallurgy by Sydney, H. Avner. McGraw-Hill, (2001).
5. Physical Metallurgy by Cahn, R. W. and Haasen, P. North-Holland, (2001).
6. Steels, Microstructures and Properties by Honeycombe, R. W. K., and Bhadeshia, H. K. D. H. Edward Arnold, (2005)
7. Modern Physical Metallurgy and Materials Engineering by Smallman, R. E. and Bishop, R. J. Butterworth-Heinemann, (1999).

Journals/Periodicals  
World Wide Web

## **MME 203 Powder Metallurgy 3(3,0)**

### **Course Outlines:**

Introduction to powder metallurgy, Applications of powder metallurgy, advantages and limitations of powder metallurgy

Production of metallic powders, powder characterization techniques, Powder conditioning and function of additives

Compaction of metal powders, cold compacting methods, hot compacting methods, physical characteristics of powder compacts, compaction defects

Sintering theory and practices, solid state and liquid phase sintering, enhanced sintering techniques, sintering atmospheres, thermodynamics of sintering, sintering furnaces

Design of powder metallurgy processes and parts, design consideration for powder metallurgy parts, metallographic interpretation of sintered products

Inspection and quality control for P/M parts, the economics of P/M production, case studies in powder metallurgy, new development in powder metallurgy processes

# Curriculum

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## **Recommended books:**

1. Powder Metallurgy: Science, Technology, and Materials by Anish Upadhyaya, Gopal Shankar Upadhyaya. University Press, (2011)
2. Powder metallurgy: science, technology and applications by P. C. Angelo, R. Subramanian. (2009)
3. Fundamentals of Powder Metallurgy by West, William G, F. Leander, Pease. Metal Powder Industries Federation, (2002)
4. Atomization of Melts for Powder Production and Spray Deposition by Yule, A.J., and Dunkley, J. D. Clarendon Press, (1994)
5. Powder Metallurgy Science by R.M. German. 2nd ed. (1994)
6. Fundamental Principles of Powder Metallurgy by W. D. Jones. Edward Arnold Publications, London, (1960)

Journals/Periodicals  
World Wide Web

## **MME 204 & MME 204L Polymeric Materials 4(3,1)**

### **Course Outlines:**

Types of forces of attraction and their relationship with the materials' classification. A brief review of organic chemistry.

An introduction to polymeric materials: Thermoplastic and thermosetting plastics.

Classification criteria for polymeric materials. Molecular structure of backbone chains of polymers. Principles and kinetics of polymerization. Functionality of monomers for addition and condensation reactions. Mechanism of condensation reactions (step growth) with example: Carother's equation and its limiting forms, Self-catalyzed, Externally catalyzed. Mechanism of addition reactions (chain growth) with examples (Anionic polymerization and Cationic polymerization: Initiation, Propagation, Termination

Systems of polymerization: Homogenous and Heterogeneous. Techniques of polymerization: Bulk technique, Solution technique, Suspension technique, Emulsion technique. Additives for polymers: Fillers, Plasticizers, Stabilizers, Coloring matters, Lubricants, Flow promoters, Crosslinking agents. Glass transition temperature, Types of motions that exist in the structure at different stages. Polymers' crystallinity, the structure and factors influencing crystallinity.

Liquid crystal polymers: Introduction, Types of disorder, Reason for LC behavior, Types of LCs, Architectural units for LCs, Effect of the arrangement of architectural units on the properties of LCPs

# Curriculum

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Visco-elastic behavior of polymeric materials: Viscous flow of fluids, Difference between time dependent and time independent deformation.

Degradation of polymeric materials: Thermal degradation, Oxidative and UV degradation, Chemical degradation (swelling, Dissolution), Radiation degradation, Mechano-degradation, Biological degradation

Fabrication techniques for thermoplastics: Injection molding technique (Sandwich process, Reaction process), Thermoforming, Extrusion (Pellet production, Profile formation, Film blow molding, Extrusion blow molding, Extrusion stretch blow molding, Extrusion coating, Extrusion wire coating, Co-extrusion

Fabrication techniques for thermosets: Compression molding, Transfer molding

Polymer matrix composites: Role of dispersed phase, Role of continuous phase, Role of an interface, Types of PMCs.

Fabrication techniques form PMC: Hand lay-up method, Resin transfer molding, Filament winding, Pultrusion

## **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

## **Recommended Books:**

1. The Chemistry of Polymers by Jhon W. Nicholson. Royal Society of Chemistry, (2011)
2. Principles of Polymer systems by F. Roderiguez. 5<sup>th</sup> ed. McGraw Hill, (2003)
3. Fundamentals of Materials Science and Engineering by William D. Callister, David G. Rethwisch, An Integrated Approach. Wiley (2012)
4. Foundations of Materials Science and Engineering by William Smith, Javad Hashemi. 5th ed. (2009)
5. Polymer Science and Technology by Joel R. Fried. 2<sup>nd</sup> ed. Prentice Hall, (1995)

Journals/Periodicals  
World Wide Web

## **MME 205 Iron and Steel Making Processes 3(3,0)**

### **Course Outlines:**

Introduction to Iron and Steel Making Processes

Iron and steelmaking fundamentals: A brief review of solution thermodynamics

# Curriculum

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Mineral processing of Iron Ores (Crushing, Grinding, Sizing, Classification and Concentration Techniques)

Blast Furnace Process: Brief History, Introduction to modern Blast Furnace, Raw Materials for Iron making, Blast Furnace Process Description, Agglomeration processes: Sinter and Pellet making processes. Blast Furnace Reactions, Importance and role of slag in blast furnace process. Blast Furnace gas cleaning system, Blast Furnace Stoves, Recent developments in BF process

Introduction to Alternate Iron Making Processes: Coal and gas based process for sponge iron making, Smelting Reduction Processes

Introduction to steelmaking fundamentals, Oxidation reactions in steelmaking processes, role of slag in steelmaking.

Primary Steelmaking Processes: Basic Oxygen Furnace Design and Process Description, Lance design and Refractories in BOF

Electric Arc Furnace, Design and process description, Latest trends in EAF Process

Induction Furnace, design and process description, Latest trends in IF Process

Secondary Steelmaking Processes: Argon Purging, Ladle de-oxidation, Degassing and emerging ladle metallurgy processes

Continuous Casting: Recent trends in continuous casting technology

Charge Calculations for Iron and Steel Making Processes

Concepts of Standards and Specification of Ferrous Alloy Systems in Irons and Steels

## **Recommended Books:**

1. Extractive Metallurgy 1: Basic Thermodynamics and Kinetics by Alain Vignes. 1<sup>st</sup> ed. Wiley, (2010)
2. Extractive Metallurgy 2: Metallurgical Reaction Processes by Alain Vignes. 1<sup>st</sup> ed. Wiley, (2011)
3. Extractive Metallurgy 3: Processing Operations and Routes by Alain Vignes. 1<sup>st</sup> ed. Wiley, (2010)
4. Metallurgy Fundamentals: Ferrous and Non-Ferrous by Daniel A. Brandt and J. C. Warner. 5<sup>th</sup> ed. (2009)
5. Iron Making and Steel Making, Theory and Practice by Ahindra Ghosh and Amit Chatterjee. Prantice Hall India, (2008)
6. An Introduction to Modern Iron Making by R.H. Tupkary and V.R. Tupkary. 4<sup>th</sup> ed. Khana Publications India, (2013)
7. An Introduction to Modern Steel Making by R. H. Tupkary and V. R. Tupkary. 7<sup>th</sup> ed. Khana Publications India, (2008)

# Curriculum

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8. The Making Shaping and Treating of Steel by H.E. McGannon. 9<sup>th</sup> ed. The Pittsburgh United States Steel, (1971)
9. Secondary Steel Making: Principles and Applications by Ahindra Ghosh. 1<sup>st</sup> ed. CRC Press, (2000)  
Journals/Periodicals  
World Wide Web

## **MA 242 Engineering Statistics 3(3,0)**

### **Course Outlines:**

Introduction & role of statistics in engineering.

Population & samples, Variables, Methods of displaying data sets, Stem & leaf display, Histogram, Histogram shapes, Boxplot, Bar chart, Pareto diagram, Dot diagram, Frequency distributions & their graphs, Outlier.

Mean, Median, Quartile, Percentile, Range, Deviation from mean, Sample variance, Sample standard deviation, Coefficient of variation.

Probability, Concepts & definitions, Basic theorems of probability, Law of total probability, Bayes theorem, Discrete and continuous random variables and their probability distributions, Density and distribution functions; Expectation.

Mean & variance of discrete & continuous random variables, Binomial distribution, Poisson distribution, Normal distribution, t-distribution, Chi-square distribution, F-distribution.

Sampling techniques and sampling distribution; Point estimation and interval estimation of parameters, Least square linear & polynomial regression, Linearization of nonlinear models, Correlation, Design of experiments, Analysis of variance.

### **Recommended Books:**

1. Applied Statistics for Engineers & Scientists by Devore/Farnum. 3<sup>rd</sup> ed. Thomas.
  2. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole. 8<sup>th</sup> ed. Pearson Educational International, (2007).
  3. Probability and Statistics for Engineering and Sciences. 8<sup>th</sup> ed. CENGAGE Learning.
  4. Advanced Engineering Mathematics by Erwin Kreyszig. 11<sup>th</sup> ed. John and Wiley and Sons.
  5. Applied Statistics and Probability for Engineers by Montgomery and Runger. 3<sup>rd</sup> ed. John and Wiley and Sons.
  6. Probability and Random Variables and Stochastic Processes by Papoulis Athanasios, 3<sup>rd</sup> ed. McGraw-Hill Inc.
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# Curriculum

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7. Introduction to Statistical Theory by Muhammad Shehzad and Sher Muhammad. Ilmi Kitab Khana Urdu Bazar Lahore.
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## **FIFTH SEMESTER**

### **MME 311 Mechanical Behavior of Engineering Materials 3(3,0)**

#### **Course Outlines:**

A review of the structure of crystalline materials, Crystallographic defects.

Elasticity: Deformation modes, Stress and Strain, Atomic interactions, Hooke's law, Elastic strain energy.

Plasticity: Engineering and True strain, Stress-strain diagram and their analysis, Flow curve, Yield criteria of Metals, Hardness

Notches: Stress concentration factor, Neuber's rule, Tensile testing of notched specimens.

Fracture Mechanics: Introduction, Fracture modes, Linear elastic fracture mechanics (LEFM): Stress field near crack tip, Theoretical cohesive strength, Griffith criteria – Orowan's modification, Strain energy release rate, Stress intensity factor, Fracture toughness and design, Material's behavior during crack propagation (elastic),  $K_{IC}$  Plain strain toughness testing, Fracture parameters of different materials. Elastic-Plastic fracture mechanics: crack tip opening displacement, J-Integral, Material's behavior during crack propagation (plastic), Measurement of elastic-plastic fracture parameters.

Mechanical behavior of Metals: Theoretical Strength, Dislocations, Types of dislocations and their stress field, movement of dislocations, Slip systems, Critical resolved shear stress, Taylor factor, Dislocation interaction, Generation—multiplication--annihilation of dislocations, Forces on dislocations, Observation of dislocations, energy of dislocations, Dislocation in f.c.c. structure, Perfect & partial dislocations, Stair-rod dislocation, Thompson tetrahedron. Overcoming obstacles: Athermal processes, Thermally activated processes, Climb and Cross slip, Ductile-brittle transition, Intersection of dislocations (jogs and kinks). Strengthening Mechanisms: Work hardening, Grain boundary strengthening, Solid solution strengthening, Particle strengthening, Hardening of steels. Twinning deformation.

Severe plastic deformation and production of nano-crystalline materials via: Equal channel angular pressing, Accumulative roll bonding, Friction stir process etc.

Fracture behavior of metallic materials, deformation and fracture in single crystal & poly-crystalline material, Shear and Cleavage fractures, different types of embrittlement

Mechanical behavior of thin films and coatings, Rockwell C indentation test, scratch test, in-situ Tensile test, wear test, Agrawal and Raj method

Mechanical behavior of Ceramics and glasses: Fracture behavior, Weibull Modulus. Mechanical behavior of Polymers: Visco-elastic deformation and fracture behavior of polymeric materials (thermosettings and thermoplastics). Mechanical behavior of different types of composites.

# Curriculum

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Creep: Structural changes during high temperature deformation, mechanism of creep under various conditions of stress and temperature. Materials for high-temperature use, Superplasticity.

Fatigue: Structural changes during fatigue, theories of fatigue crack initiation, propagation of fatigue cracks, fatigue at elevated temperature. Metallurgical aspects of fatigue failures.

Bending Fractures, Torsional Fracture, stress-corrosion and wear failures.

## **Recommended Books:**

1. Mechanical Behaviour of Engineering Materials: Metals, Ceramics, Polymers by Joachim Roesler, Harald Harders, Martin Baeker. Springer, (2010)
2. Deformation and Fracture Mechanics of Engineering Materials by Richard W. Hertzberg, Richard P. Vinci, Jason L. Hertzberg. Wiley, (2012)
3. Introduction to Dislocations by D. Hull and D.J. Bacon. 5<sup>th</sup> ed. Elsevier, (2011)
4. Mechanical Metallurgy by George E. Dieter. SI Metric ed. McGraw Hill Inc., (2002)

Journals/Periodicals  
World Wide Web

## **MME 312 & MME 312L Ceramic Materials 4(3,1)**

### **Course Outlines:**

Introduction to various classes of ceramics, Traditional versus advance ceramics, History, uses and applications,

Bonding Characteristics of Ceramics, Ionic versus covalent bonding in ceramics.

Crystal Structures of Ceramics – Binary ionic compounds, Composite crystal structure, Structures of Covalent Ceramics, Pauling's Rules, Silicate Structures, ,

Use of Ceramics as refractories in metallurgical industries. Refractory materials, their types and classifications.

Production and processing of refractory bricks and other shapes of traditional ceramics, structural changes during processing/sintering of refractories.

Selection and application of refractories for ferrous and non-ferrous industries.

Production and processing of ceramics, Basic principles and techniques of consolidation and shaping of ceramics: powder pressing - uniaxial, biaxial and cold isostatic and hot isostatic, injection moulding, slip casting, tape-casting, Sintering and sintering theory of ceramics, Defects in Ceramics, Introduction, Types

# Curriculum

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of defects and Quasichemical Defect Reactions, Kroger Vink notation and use in defect equations, Electronic Defects and Band Structure.

Glasses, glass-system, vitrification process in glasses, Structures of Glasses, Zachariasen's Rules)

## **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

## **Recommended Books:**

1. Modern Ceramic Engineering: Properties, Processing, and Use in Design by David Richerson. 3<sup>rd</sup> ed. CRC Press, (2005)
2. Ceramic and Glass Materials: Structure, Properties and Processing by James F. Shackelford (Editor), Robert H. Doremus. 1<sup>st</sup> ed. Springer, (2008)
3. Fundamentals of Ceramics by M W Barsoum. 1<sup>st</sup> ed. CRC Press, (2002)
4. Engineering Ceramics by Bengisu M. Springer, (2001).
5. Introduction to Ceramics by Kingery, Bowen and Uhlmann. 2<sup>nd</sup> ed. Wiley, (1976).
6. Electroceramics by A.J. Moulson. Wiley, (2003)

Journals/Periodicals  
World Wide Web

## **MME 301 Electrical and Magnetic Materials 3(3,0)**

### **Course Outlines:**

Classification and concept of Electrical and Electronic Materials.

Development, processing and characterization of materials via conventional and advanced routes.

Reaction of materials/components to very low and moderate temperatures.

Operation of materials in corrosive environments.

Development, processing and characterization of semi-conductor materials via bulk and thin film deposition routes.

Graphical representation of magnetic properties, Magnetization curve, Hysteresis loop. Squareness factors.

Types of magnetic behavior. Ferromagnetic domains. Experimental evidence for domains. Single domain particles. Domain wall motion. Hindrances to wall motion.

# Curriculum

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Soft Magnetic Materials: Desirable properties for soft magnetic materials. Potential applications of soft magnetic materials.

Hard Magnetic Materials: Properties of Hard magnetic materials. Origin of Ferromagnetism in Rare Earth based permanent magnets. Potential applications of permanent magnets.

## **Recommended Books:**

1. Fundamentals of Materials Science and Engineering by William D. Callister, David G. Rethwisch, An Integrated Approach. Wiley (2012)
2. Foundations of Materials Science and Engineering by William Smith, Javad Hashemi. 5th ed. (2009)
3. The Science and Engineering of Materials by Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright. 6th ed. (2010)

Journals/Periodicals  
World Wide Web

## **MME 302 Non-Ferrous Extractive Metallurgy 3(3,0)**

### **Course Outlines:**

Early developments in metal extraction: Introduction, discovery of metals and their importance, important landmarks, nonferrous metals in history, uses of nonferrous metals.

Sources of nonferrous metals: Sources in land and sea, exploration methods.

Mineral Processing of different types of non-Ferrous ores (crushing, grinding, sizing, classification and concentration)

Principles of metals extraction: Thermodynamic principles, homogeneous and heterogeneous reactions, Ellingham diagrams, kinetic principles, principles of electro-chemistry.

General methods of extraction: Pyro-metallurgy – calcination, roasting and smelting, Hydrometallurgy – leaching, solvent extraction, ion exchange, precipitation, and electrometallurgy – electrolysis and electro-refining. Charge and energy calculations.

General methods of refining: Basic approaches, preparation of pure compounds, purification of crude metal produced in bulk.

Extraction of metals from oxide sources: Basic approaches and special features of specific extraction processes, extraction of metals such as magnesium, aluminum, tin and ferro-alloying elements, production of ferro-alloys.

Extraction of metals from sulphide ores: Pyro-metallurgy and hydro-metallurgy of sulphides, production of metals such as copper, lead, zinc, nickel etc.

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Extraction of metals from halides: Production of halides and refining methods, production of reactive and nuclear reactor metals. Methods of extraction of metals such as titanium, rare earths, uranium, thorium, plutonium, beryllium, zirconium etc.

Production of precious metals: Methods applied for gold, silver and Pt group metals.

Secondary production of metals and utilization of wastes, Energy and environmental issues in nonferrous metals extraction

## **Recommended Books:**

1. Non-Ferrous Extractive Metallurgy - Industrial Practices by Roger Rumbu. (2010)
2. Extraction of Nonferrous Metals by H.S. Ray, R. Sridhar and K.P. Abraham. Affiliated East West Press Pvt Ltd., New Delhi, (2007).
3. Energy in minerals and metallurgical processes by H.S. Ray, B.P Singh and Sarama Bhattacharjee. Allied Publishers Ltd, New Delhi, (2005)
4. Principles of Extractive Metallurgy by T. Rosenqvist. 2<sup>nd</sup> ed. (reprinted), McGraw Hill, New York, (2004)
5. Extraction Metallurgy by J. D. Gilchrist. 3<sup>rd</sup> ed. (1989)
6. Nonferrous Extractive Metallurgy by Charles Burroughs Gill. Wiley, (1980)

Journals/Periodicals  
World Wide Web

## **MME 303 & MME 303L Inspection and Quality Assurance 4(3,1)**

### **Course Outlines:**

Introduction (load/Force, stress & types, Strains & types, deformation of a body, Poisson's ratio, Hook's law plane stress, plane strain condition, stress concentration)

Hardness Testing (Arbitrary or indentation hardness, Rebound of dynamic hardness, Scratch hardness, Wear hardness, Scope & applicability, Elastic, dynamic or rebound hardness test, Sclerescop, Abrasion test, File test. Macrohardness Testing (Brinell, Rockwell), Microhardness Testing (Knoop, Vicker, Ultrasonic).

Suitability of testing methods for various materials/specimen.

Tensile testing (Tensile testing machine, Engineering Stress Strain Curve, Elastic limit, proportionality limit, yield point, yield point phenomenon & Luders bands, Measures of ductility, Modulus of elasticity, Resilience, Toughness, True-stress, true-strain concepts, ductile & brittle fractures, True stress at

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maximum load, True fracture stress, strain, True local necking strain, Power law or Holloman's relationship, Effect of strain rate & temperature, Notched tensile test. Compression test (Stress distribution, Shear behavior, Bauschinger's effect, Strain softening)

Bend test, Torsion test (Rotational-Linear Parallels, Polar Moment of inertia, torsion properties, Torque Twist Diagram, Torsional stresses for large plastic strains, Types of torsional failures, Mohr's Circle, Hot Torsion Test.

Fatigue test (SN curve), Creep test (creep curve), Impact Test (Izod, Charpy), Temperature Transition Curve (Ductile to Brittle Transition Temperature, Metallurgical Factors Affecting Transition Temperature,

Non-destructive testing (Visual Testing, Leak Testing, Acoustic Emission Testing, Radiographic method, Electromagnetic method, Magnetic particle method, Magnetic flux leakage, Eddy Current Testing, Dye penetrant method, ultrasonic method, Thermal/infrared testing, mechanical method, Vibration Analysis, Boroscopy, Photo-elastic method of measuring)

Reliability and maintainability, inspection of different types of materials and products for evaluation of quality reliability of flaw detection by non-destructive inspection, quality control applications of nondestructive inspection. Introduction to standards. Familiarization of standards for testing of materials, ASTM, BS, JIS GOST and ISO. Pakistan Standards, Quality assurance for final products, Measures for quality control.

## **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

## **Recommended Books:**

1. Handbook of Nondestructive Evaluation by Chuck Hellier, 2<sup>nd</sup> ed. McGraw Hill, (2012)
2. Introduction to Non-Destructive Testing, a training guide by Paul E. Mix. 2<sup>nd</sup> ed. Wiley, (2005)
3. Practical Non-Destructive Testing by Baldev Raj, T. Jayakumar, M. Thavasimuthu, 2<sup>nd</sup> ed. Woodhead Publishing Limited, (2002)
4. Mechanical Testing & Evaluation, Vol. 8 - ASM Handbook
5. Mechanical Metallurgy by George E. Dieter. McGraw-Hill Book Company (UK) Ltd., (2002)
6. Testing of Metals by Dr. Fazal Karim, Ferozsons Lahore, (1995)

Journals/Periodicals  
World Wide Web

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# Curriculum

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## **SIXTH SEMESTER**

### **MME 304            Process Control and Instrumentation            2(2,0)**

#### **Course Outlines:**

Introduction to process control: Process Control, Definitions of the Elements in a Control Loop, Units and Standards, Instrument Parameters

Temperature Measurement: Introduction, Temperature and Heat, Thermal expansion, Heat transfer, Liquid Expansion Thermometers (Mercury in Glass, Liquid in glass) , Bimetallic strip Thermometers, Pressure-Spring thermometers, Resistance Temperature Devices (Band Gap Theory, behavior of conductors, semiconductors and nonconductors), thermistors, Thermocouples (Seebeck & Peltier Effect, Thomson Effect, Law of intermediate Temperature, Law of Homogenous metal, Law of homogenous temperature), Pyrometers (Radiation fundamentals, Total Radiation Pyrometer, Selective Radiation Pyrometer)

Pressure Measurement: Introduction to pressure measurement, Pressure Formulas, Manometers (U-tube, Well type, Inclined Leg), Diaphragms, Bellows, Borden Tubes, Dead weight gauge, Secondary transducers (Resistive, Inductive, Capacitive, Photoelectric, Piezoelectric), Low Pressure Measurement: McLeod Gauge, Knudsen Gauge, Thermocouple and Pirani gauge, Ionization Gauge

Flow Measurement: Introduction to Bernoulli's theorem and fluid mechanics, Head type flow meters (Orifice plate, Venturi tube, pilot tube) Rotameter, Anemometers, Electromagnetic flow meters, Mechanical Meter (turbine type), Ultrasonic meter (Doppler Frequency Shift, Transit time)

Displacement Measurement: Potentiometer, Variable reluctance devices, variable capacitance devices. Strain Measurement: Foil type, strain gauge, Strain gauge Load Cell, Load Measurement

Level Measurement: Differential Pressure, Displacer, Bubbler, Capacitance, Conductance, Ultrasonic, Radar and nuclear type level measurement devices

Actuators and control: Introduction, Pressure Controllers (Regulators, Safety valves, Level regulator,) Flow Control Actuators (Globe valve, Butterfly valve, Other valve types, Valve characteristics, Valve fail safe)

Power Control (Electronic devices and Magnetic controllers) Motors (Servo motors, Stepper motors, Valve position feedback, Pneumatic feed) Application Consideration (Valves Power devices)

#### **Recommended books:**

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1. Fundamentals of Industrial Instrumentation and Process Control by William Dunn. McGraw Hill Professional, (2005)
2. Process Control Instrumentation Technology by Curtis D. Johnson. Pearson/Prentice Hall, (2006)
3. Introduction to instrumentation and control by A.K Ghosh, (2004)
4. Fundamentals of Instrumentation by Delmer Cengag. Learning, (2008)
5. Instrumentation and Control System by John Park, Steve Mackay. Newness, (2003)
6. Instrumentation Reference Book by Walt Boyes. Elsevier, (2003)

Journals/Periodicals  
World Wide Web

## **MME 321 & MME 321L Heat Treatment and Phase Transformation 4(3,1)**

### **Pre-requisites:**

Physical Metallurgy (MME 211)

### **Course Outlines:**

**Thermodynamics of Phase Transformation:** Gibbs free energy and phase equilibrium. Free-energy changes in single component system affected by variations in temperature and pressure, Clausius Clapeyron equation. Driving force for solidification. Gibbs free energy changes in binary alloys, Free energy of mixing, Estimation of bond energy, Ideal and real solutions, Ordered-disordered phases.  $G$  vs  $X_B$  curves and phase diagrams, Mechanical mixtures and solutions, Gibbs phase rule, Eutectic phase diagram. Driving Force for diffusion, free energy and diffusion, Fick's first and second laws of diffusion, Steady state diffusion, Diffusivity, Diffusivity and mobility.

**Interfaces:** Structure of interfaces, Coherent, semi-coherent and in-coherent interfaces, Free energy of interfaces, Free energy of grain boundary, bond breaking model for surface energy of solids, equilibrium shapes of crystals.

**Nucleation and Growth:** Interfaces and equilibrium, nucleation of solids from their melt, Nucleation of precipitates from a supersaturated matrix, driving force for nucleation, Growth of nuclei and precipitates, Kinetics of nucleation and Growth.

**Solid-Solid Phase Transformation and Heat Treatment:** Austenitic Phase transformation: Austenite formation on heating, kinetics of austenite formation, austenite grain size. Decomposition of austenite.

Time temperature transformation curves: effect of alloying elements on TTT diagram and equilibrium diagrams, continuous cooling transformation.



# Curriculum

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Some standard heat treatments: Annealing, Normalizing, Quenching & tempering, Age hardening.

Pearlitic transformation: Mechanism, Kinetics, effect of alloying elements, interlamellar spacing. Austempering and Bainitic transformation: Mechanism and structures of bainite.

Quenching and Martensitic Transformation: Mechanism, Kinetics,  $M_s$  and  $M_f$  temperatures, Effect of applied stress, Habit planes, Bain distortion model, Hardness of martensite, Retained austenite. Hardening, factors affecting the hardening process and hardening methods. Hardenability: Grossman's and Jominy end quench methods for hardenability testing, Quenchants: Removal of heat during quenching, characteristics of quenchants, different quenching media. Subzero treatment. Tempering of martensite. Martempering.

Different types of annealing, recovery, recrystallization and grain-growth, normalizing, oxidation and decarburization during heat treatment.

Different surface hardening techniques: carburizing, nitriding, carbonitriding, cyaniding, flame hardening, induction hardening, laser hardening, electron beam hardening.

Precipitation hardening of steels, Maraging steels, Heat treatment of die and tool steels, Heat-treatment of cast-irons, Heat treatment of common non-ferrous alloys. Defects caused during heat-treatment.

Thermomechanical treatments: Controlled rolling, hot-cold working, Ausforming, Isoforming, Marstraining, Cryoforming, Thermomechanical annealing.

## **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

## **Recommended Books:**

1. Phase Transformation in Metals and Alloys by D.A. Porter and K.E. Easterling. Chapman and Hall, (2001)
2. Physical Metallurgy by William F. Hosford. 2<sup>nd</sup> ed. University of Michigan, (2010)
3. Physical Metallurgy by Cahn and Haasen. (2001)
4. Physical Metallurgy by David E. Laughlin and Hono. 5<sup>th</sup> ed. Elsevier, (2014)
5. Practical Heat Treating by L. Dossett and H. E. Boyer. 2<sup>nd</sup> ed. ASM International, (2006).
6. Steel Heat Treatment by Totten G. E. CRC Press, (2007)
7. Heat Treatment of Metals by Vijendra Singh. Standard Publishers, India, (2009)
8. Heat Treatment: Principles and Techniques by T.V. Rajan, C.P Sharma, Ashok Sharma. 2<sup>nd</sup> ed. Prantice Hall, India, (2011)

Journals/Periodicals

# Curriculum

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World Wide Web

## **MME 305 & MME 305L Welding and Joining of Materials 4(3,1)**

### **Course Outlines:**

Introduction to Joining Principles, Classification of Joining Processes, Fusion Welding and Solid State Welding Processes, Special Welding Processes.

**Fusion Welding:** Arc Welding Processes with Case Studies, resistance Welding processes with Case Studies, Special Welding processes with Case Studies

**Solid State Welding:** Brazing, Soldering and Adhesive Bonding.

**Metallurgy of Welding:** Weldability of Ferrous and Non-ferrous Alloy Systems, Stresses in Welds, Testing and Non-Destructive Evaluation of Welds.

Formulation of WPS, WPQ and WPR, Fabrication and Repair procedures for Weld Assemblies, Welding of Dissimilar Materials with special emphasis on Metal-Ceramic and Ceramic-Ceramic Joining, recent Trends in Joining Technologies.

Polymers as joining materials, glasses as joining materials

### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

### **Recommended Books:**

1. Welding: Principles and Applications by Jeffus. 7<sup>th</sup> ed. Delmor Cengage, (2011)
2. Welding Principles and Applications by Jeffus, Roy and Thompson. 6<sup>th</sup> ed. Delmor Cengage, (2007)
3. Introduction to Physical Metallurgy of Welding by Easterling K. Butterworth Heinemann, (2000)
4. Metallurgy of Welding by Lancaster J. F. 6<sup>th</sup> ed. Wood head publishing, (1999)
5. Principles of Metal Manufacturing Process by J.Beddoes and M.J.Bibby. Elsevier, (1999)
6. Manual on Joining Processes by Welding, Brazing and Soldering by Tikku, G. L. Minerva Press, (2003)
7. Joining of Materials and Structures: From Pragmatic Process to Enabling Technology by Robert W. Messler. 1<sup>st</sup> ed. Butterworth-Heinemann, (2004)

Journals/Periodicals

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# Curriculum

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## **MME 306 Industrial and Financial Management 3(3,0)**

### **Course Outlines:**

Introduction to management, operation functions and management, production management strategy.

Scope of Production Management, Classification of production system, Functions of Production Management Department.

Operations Management (Framework, Objectives, Global operations, management, Operations Functions, Planning & controlling the operations).

Manufacturing system design, Operations system design, Production management strategy, Forecasting requirements, Approaches to forecasting (Based on judgment & opinion, Time series, historical data, Associative forecast)

Decision making, Management in service environments, Plant (Location, Layout, Design, Equipment & Maintenance).

Financial Management, corporate finance and capital markets, emphasizing the financial aspects of managerial decisions, the valuation of real and financial assets, risk management and financial derivatives, the trade-off between risk and expected return, and corporate financing and dividend policy.

Project Management (project life cycle, work breakdown structure, Gantt charts, Activity-on-node diagram, PERT, CPM)

Personnel management, Health & safety requirements, Ergonomics (Human Engineering),

Quality, Quality Control, Quality assurance, Fundamental factors affecting quality, Inspection (purpose, type, methods, drawbacks), seven tools for QC, Total quality management, Quality management systems, ISO-9000, ISO-14000

### **Recommended Books**

1. Production Control in Practice by Lockyer, K. G. Pitman, (2007)
2. Production and Operations Management by Keith Lockyer. Pitman, ELBS ed., (2000)
3. Production & Operations Management by P. Rama Murthy, revised 2<sup>nd</sup> ed. New Age international publishers, (2009)
4. Production and Operation Management by William Gavett Harcourt. Brace & World, (2006)
5. Production & Operations Management by William J. Stevenson. 5<sup>th</sup> ed. McGraw-Hill, (1996)

Journals/Periodicals

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# Curriculum

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## **MME 307L Computational Methods in Materials Engineering 2(0,2)**

### **Pre-requisites:**

Basic knowledge of computing

### **Course/Lab Outlines:**

Introduction to computational material science and engineering

Introduction to modelling and simulation software; 3D part and assembly modelling, sheet metal modeling, flow simulation, finite element analysis, stress analysis using finite element modelling

Modelling of grain growth and microstructure, phase transformation, mass transfer and heat transfer

Learning of Origin Pro software

Atomistic modeling of defects in materials, modelling of dislocation behavior, elastic properties, plastic deformation and mechanical behavior of engineering materials

### **Recommended books:**

1. Introduction to Materials Modelling by Zoe H. Barber. Maney Publishing, (2005)
2. Computational Materials Science by Dierk Raabe. Wiley VCH Verlag GmbH, (1998)
3. Multiscale Materials Modelling: Fundamental and Applications by Z. Xiao Guo. Woodhead Publishing Limited, Cambridge, (2007)
4. An Introduction to Computer Simulation by M.M. Wolfson, G.J. Pert. Oxford, (1999)
5. The Art of Molecular Dynamics Simulation by D.C. Rapaport. Cambridge, (2004)

Journals/Periodicals

World Wide Web

## **MME 308 Characterization of Engineering Materials 3(3,0)**

### **Course Outlines:**

Introduction to characterization techniques and their importance in Materials science

Production of X-rays and their applications, absorption of X-rays, use of filters, X-ray diffraction, Bragg's law, structure factor calculations, diffraction methods, debye-scherrer, laue back-reflection, and rotating-crystal method. X-ray diffraction pattern Indexing of XRD patterns. Precise lattice parameter determination by software use. Determination of particle size and micro/macro strains. Chemical analysis by X-rays & fluorescence

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Stereographic projections; orientation of crystal with respect to a reference, rotation of crystal around an axis, planes of a zone

Crystal structure determination, orientation of single crystals, pole figures, Applications of X-ray diffraction.

Scanning electron microscope; construction, interaction of electrons with matter, modes of operation of SEM, image formation of plane and fractured surfaces. Chemical analysis using EDS and WDS, Electron diffraction and basics of transmission electron microscopy Image formation, resolving power, magnification, depth of focus, elementary treatment of image contrasts, important lens defects and their correction. Bright field and dark field images. Introduction to Scanning Tunneling microscope and its various types e.g Atomic force microscopy, Piezo-force microscopy, magnetic force microscopy etc. Introduction to Raman spectroscopy and its use in materials science.

Spectroscopic techniques, spark emission spectroscopy, absorption etc.

## **Recommended Books:**

1. Characterization of Materials by Elton N. Kaufmann. 3 Volume Set, Wiley, (2012)
2. Microstructural Characterization of Materials by Brandon, D. and Kaplan, W. D. 2<sup>nd</sup> ed. Wiley, (2008).
3. Characterization of Materials: Electron Beam Analysis of Materials by Wachtman, J. B. 2<sup>nd</sup> ed. Butterworths Heinemann, Chapman and Hall, (1984)
4. X-Ray Diffraction by B. D. Cullity. 3<sup>rd</sup> ed. Prentice Hall, (2001)
5. X-Ray Diffraction by B.E. Warren. Reprint Edition. Dover Publications, (1990)
6. ASM Handbook, Vol. 10 for reference

Journals/Periodicals  
World Wide Web

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# Curriculum

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## **SEVENTH SEMESTER**

### **MME 420 & MME 420L Solidification of Metals and Alloys 4(3,1)**

#### **Pre-requisites:**

Foundry Engineering (MME 210)

#### **Course Outlines:**

A review of nucleation & growth mechanisms, Freezing of pure metals & alloys.

Heat transfer (resistance to heat transfer, increased heat transfer, convection), Development of matrix structure, factors affecting initiation & termination of freezing, solidification range, directional solidification, Segregation (planar front segregation, micro segregation), dendritic segregation, gravity segregation), Solidification Structures.

Solidification defects (Shrinkage & its distribution, Gas porosity, linear contraction, hot tearing, Cold cracking, Residual stress etc.),

Reaction of melt with environment, vaporization, Gas transport in melts, Surface film formation, Pouring & Feeding Mechanisms, feeding criteria, Riser shape, size & location,

Use of insulations, chills, exothermic sleeves & compounds, padding, etc. for directional solidification,

Fluidity & its measurements (effect of velocity, viscosity, surface tension, solidification time), Turbulence in gating systems,

Use of foundry chemical agents, e.g. fluxes, degassers, grain refiners, die casting lubricants, mold coats etc., Casting Design Considerations, Inspection & Testing

Gating System Types & Design, Foundry Mechanization, Storage, handling, reclamation & handling of molding sands

#### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

#### **Recommended Books:**

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1. Principles of metal casting by Richard W Heine, Carl R Looper, Philip C Rosenthal, 2<sup>nd</sup> ed. (reprinted) – Tata McGraw-Hill Edition, (2008)
2. Castings by John Cambell. 2<sup>nd</sup> ed. Elsevier, (2004)
3. Principles of Foundry Technology by P L Jain. Tata McGraw-Hill Edition, (2008)
4. Manufacturing processes – II by H S Bawa. 1<sup>st</sup> ed. Tata McGraw-Hill Edition, (2006)

Journals/Periodicals  
World Wide Web

## **MME 421 Metal Working Processes 3(3,0)**

### **Pre-requisites:**

Mechanical Behavior of Engineering Materials (MME 311)

### **Course Outlines:**

Principles of metal forming processes, Softening and Hardening Mechanism, Metal-Working in the Re-crystallization, Non-recrystallization and Two-Phase regions, Concept of dynamic, static recovery & re-crystallization, Aspect Ratio.

Rolling, process and equipment, forces in rolling, metal flow, defects and their prevention.

Forging, process and equipment, Forces in Forging, grain flow, forging defects and their prevention.

Extrusion, Processes and equipment, extrusion-defects. Wire-drawing.

Sheet-metal working, stretch forming, deep drawing, continuous roll forming.

Machinability, tool design, chip formation, factors affecting machinability.

### **Recommended Books:**

1. Introduction to Manufacturing Processes by Mikell P. Groover. Wiley (2011)
2. Manufacturing Processes for Engineering Materials by Serope Kalpakjian. 5<sup>th</sup> ed. Prentice Hall, (2007)
3. Engineering Materials-2 by Ashby, M. F. and Jones, D. R. H. Pergamon, (2005)
4. Mechanical Metallurgy by George E. Dieter. SI metric edition. McGraw Hill, (2002)
5. Manufacturing Engineering Handbook by Hwaiyu Geng. McGraw-Hill, (2004)

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# Curriculum

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## **MME 422 Advance Ceramics 3(3,0)**

### **Pre-requisites:**

Ceramic Materials (MME 312)

### **Course Outlines:**

Review of basics and introduction to advanced ceramics, Engineering applications: at room and high temperatures, oxide and non-oxide ceramics, their chemical formulae, crystal and defect structures, non-stoichiometry and typical properties, Property-microstructure relationship, Preparation of single crystal, thick and thin film ceramics

Characterization and property measurement of ceramics. Alumina ceramics. Zirconia ceramics. SiC ceramics. Si<sub>3</sub>N<sub>4</sub> ceramics. Nuclear ceramics. Raw materials and manufacturing processes.

Electrical behavior introduction, insulating (dielectric, ferroelectric, piezoelectric, pyroelectric) semiconducting, conducting, superconducting and ionically conducting ceramics, functionally graded, smart/ Intelligent, and nano- ceramics - basic principles, preparation and applications, specific materials, their applications and case studies.

Introduction to Bio-medical applications of ceramic materials. Ceramics for energy and environment technologies – an introduction including fuel cell, Thermoelectrics etc.

### **Recommended Books:**

1. Fundamentals of Ceramics by M W Barsoum. 1st ed. CRC Press, (2002)
2. Modern Ceramic Engineering: Properties, Processing, and Use in Design by David Richerson. 3<sup>rd</sup> ed. CRC Press, (2005)
3. Engineering Ceramics by Bengisu M. Springer, (2001).
4. Introduction to Ceramics by Kingery, Bowen and Uhlmann. 2nd ed. Wiley, (1976).
5. Ceramics Processing and Sintering by M.Rahman. CRC Press, (2003)
6. Electroceramics by A.J. Moulson. Wiley, (2003)

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## **MME 401 Nuclear Materials 2(2,0)**

### **Course Outlines:**

Introduction of nuclear energy, Working of a nuclear fission reactor,



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Classification of nuclear fission reactors, Gas cooled reactors

Light water reactors, Heavy water reactors, Liquid metal fast breeder reactors

General properties in the selection of nuclear reactor materials, Special properties in the selection of nuclear reactor materials

Classification of primary components and main materials for nuclear fission reactors

Nuclear fuel materials, structural materials, moderator, reflector and blanket materials, Control element materials, coolants, shielding materials

Introduction, classification of crystal imperfections or defects, Radiation effects or damages by fast neutron, irradiation effect on material properties, irradiation effect on nuclear properties, physical properties, thermal properties, Irradiation effect on mechanical properties, Creep rate, creep life, irradiation swelling annealing of irradiation damages

Metallic uranium introduction, production of metallic and ceramic uranium fuels, Uranium metal and its properties, corrosion, u-alloys, Primary irradiation effects on uranium fuels

Introduction to ceramics uranium fuel, ceramic uranium compounds, Uranium dioxide fuel fabrication, production, properties, irradiation effects, Uranium carbide fabrication, production, properties, irradiation effects, Uranium nitride fabrication, production, properties, irradiation effects

Plutonium fuel introduction occurrence and production, Nuclear physical and mechanical properties, Ceramics plutonium compounds production properties irradiation effects corrosio,

Breeding ratio, breeding gain to doubling time production properties irradiation effects, Introduction, occurrence, extraction and production of thorium, Nuclear, physical, thermal and mechanical properties, Irradiation effect on thorium, Corrosion effect, Structural Materials(cladding), Moderator, Reflector, Blanket and Coolant Materials

## **Recommended Books:**

1. Nuclear Materials by Hemsworth. Nova science PUB inc. (2011)
2. The American Society of Mechanical Engineers: Performance and Evaluation of Light Water Reactor Pressure Vessels. (1987)
3. Introduction to Nuclear Reactor Theory by J. Lemarsh. Addison-Wesley, (2002)
4. Nuclear reactor materials and Application by Benjamin. 1<sup>st</sup> ed. (1983)
5. Nuclear reactor engineering by Glasstone. Springer, (1994)

Journals/Periodicals

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# Curriculum

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## **MME 402 Nano Materials 2(2,0)**

### **Course Outlines:**

Overview of Nanostructures and Nanomaterials, Synthesis of nanomaterials (Bottom up and bottom down techniques)

Nanostructures: Zero Dimensional nanomaterials: Nanoparticles, Quantum Dots, One-Dimensional nanomaterials: Nanowires nano-rods, carbon nanotubes, Two-Dimensional nanomaterials: Thin films and monolayers,

Carbon-based nanomaterials: Carbon nanotubes, Graphene, Nanostructured carbon

Applications of nanostructures: Reinforcement in Ceramics, Drug delivery, Giant magneto- resistance, etc. Cells response to nanostructures.

Overview of characterization of nanostructures and nanomaterials. Focus on: Brunauer-Emmett-Teller (BET) technique, Transmission Electron Microscopic techniques, Auger Electron Spectroscopy, X-ray Photoelectron Spectroscopy, Electron Energy Loss Spectroscopy.

Surfaces and interfaces in nanostructures. Ceramic interfaces, Superhydrophobic surfaces, Grain boundaries in Nano-crystalline materials, Defects associated with interfaces.

Overview of properties of nanostructures and nanomaterials (Electrical, Magnetic and Optical properties), Thermodynamics of Nanomaterials, Deformation behavior, Fracture and creep of nanomaterials.

Nano-biotechnology, Nano-mechanics and nano-tribology. Nanotechnology and its prospects for industry.

### **Recommended Books:**

1. Nanostructures and Nanomaterials: Synthesis properties and applications by Cao, G., Wang, Y. 2nd ed. World Scientific, Singapore, (2011).
2. Nanoscale Science and Technology by Kelsall, Hamely & Geoghegan,. Wiley, (2005)
3. Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers and Architects by D. Michael Ashby, Paulo Ferreira and Daniel L. Schodek. Butterworth Heinemann, (2009).

Journals/Periodicals

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## **Final Project-I MME 411 3(0,3)**

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# Curriculum

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## **EIGHTH SEMESTER**

### **MME 403 & MME 403L Composites Materials 4(3,1)**

#### **Course Outlines:**

Introduction to composite materials, Classification of Composites, Role of Interface

Fibers, whiskers and particulates in composites: Synthesis and properties of glass fibers, carbon fibers, aramid fibers, metallic and ceramic fibers and particulates

Matrixes: Properties and applications of different polymer matrixes, metal matrixes and ceramic matrixes

Manufacturing of PMC's: Hand layup, Bag molding, Filament winding, RTM (resin transfer molding), Pultrusion and other related processes

Manufacturing of MMC's: Infiltration Processes, Dispersion Processes, Spray Processes,

Solid State methods, Powder Consolidation, Deformation Processing of Metal Matrix Composites

Manufacturing of CMC's: Powder pressing, reaction bonding, infiltration and other processes

Mechanical Properties of Composites, Mechanics of composites, Factors effecting mechanical properties of composites, rule of mixture, calculations related to rule of mixtures, multi-ply laminates, Halpin-Tsai equations

Recycling of composites, Latest research trends in composites, Material Selection for different applications

#### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

#### **Recommended Books:**

1. Principles of Composite Material Mechanics by Ronald F. Gibson. 3rd ed. (2011)
2. Introduction to Composite Materials Design by Ever J. Barero. 2nd ed. (2010)
3. Composite Materials by Deborah D L Chung. Springer, (2003)
4. Composite Materials by Charles E. Bakis. ASTM International, (2003)

# Curriculum

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5. Composite Materials Science and Engineering by Krishan K. Chawla. 3<sup>rd</sup> ed. Springer, (2012)

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## **MME 404 & MME 404L Corrosion and Corrosion Control 4(3,1)**

### **Course Outlines:**

Introduction to Corrosion – Electrochemical Nature, Electrochemical cell definitions & Principles, corrosion rate expressions (based on weight loss & penetration), EMF & Galvanic Series, Nernst Equation & its application, Reference electrodes, Pourbaix Diagrams (Al, Fe, Zn E-pH diagrams), thermodynamic approach to pourbaix diagrams, equilibrium conditions, limitations of pourbaix diagrams, Corrosion Kinetics (Faraday's first law of electrolysis, Faraday's second law of electrolysis, Reversible vs irreversible electrodes, Exchange current density, Helmholtz Double layer), Polarization (Overvoltage, Activation polarization, Concentration polarization, Resistance polarization, Mixed Potential Theory, thermodynamic irreversibility & polarization, exchange current density, cathodic & anodic polarization, hydrogen overvoltage, three electrode corrosion cell), Corrosion Types (Pitting, Crevice, Cavitation, Fretting, Inter-granular, Stress corrosion cracking, Corrosion fatigue, Microbial influenced corrosion, High temperature corrosion), Passivity (types of passivity, conditions for passivity, mixed electrode behavior, film theory of passivity, adsorption theory of passivity), Cathodic protection & design of CP system (Impressed current systems, Sacrificial galvanic anodes), Anodic Protection, Electrochemical parameters & their use in corrosion studies, Corrosion Prevention Methods (Corrosion control) by: Inhibition, Coatings, Corrosion testing (weight loss method, salt spray tests, corrosion testing in soils, galvanic corrosion test, intergranular corrosion test, crevice corrosion test, microbiological activity test)

### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

### **Recommended books:**

1. Handbook of Corrosion Engineering by Pierre Roberge. 2<sup>nd</sup> ed. McGraw-Hill, (2012)
2. Corrosion and Corrosion Control by Revie and Uhlig. 4<sup>th</sup> ed. Wiley, (2008)
3. Corrosion Engineering by Mars G. Fontana. 3<sup>rd</sup> ed. Tata McGraw-Hill, (2005)
4. Principles of Corrosion Engineering & Corrosion Control by Zaki Ahmad. Elsevier Science & Technology Books, (2006)

# Curriculum

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5. Peabody's Control of Pipeline Corrosion by A.W. Peabody. 2<sup>nd</sup> ed. NACE International, (2001)

Journals/Periodicals

World Wide Web

## **MME 405 Surface Science and Engineering 2(2,0)**

### **Course Outlines:**

Tribology of surfaces: Surfaces, importance of surfaces, surface integrity, Components of surfaces, surface roughness, waviness, errors of form and flaws, roughness profile, surface textures, measurement of surface roughness and surface profiles, reasons to measure surface topography, stylus profile device for measuring surface roughness and surface profile with two readout devices, surface texture recorder, noncontact techniques, the focus-follow method, multiple-beam interferometers, friction and theories, types of wear and their mechanisms, lubrication and its regimes, applications of lubrications in wear (Ball bearings and Journal bearings).

Mechanical cleaning of surfaces: Propelling abrasive media, dry blast cleaning, sand blasting, shot blasting, wet blast cleaning, types and selection of abrasive media, applications.

Surface finishing methods: Classification, selection and applications of finishing processes, barrel finishing or tumbling, vibratory finishing, media, compounds, methods, belt Sanding, wire brushing, buffing and electropolishing

Chemical cleaning of surfaces: Classification, selection and applications of cleaning processes, alkaline cleaning, solvent cold cleaning and vapor degreasing, emulsion cleaning, molten salt bath cleaning, ultrasonic cleaning, acid cleaning, pickling and descaling.

Coatings: Paints (enamels and methods of applications, electro-coating), powder coating, hot-dip coating (galvanizing, aluminizing and tin coatings), chemical conversion coatings (chromate and phosphates), blackening or coloring metals, electroplating (zinc, chromium, gold, silver, platinum and nickel), design considerations for electroplating, anodizing, electroless-plating, electroless-composite-plating, mechanical plating, porcelain enameling, CVD and PVD techniques (Diamond, DLC, TiN etc. coatings and applications).

Surface hardening methods: A brief revision of carburizing, nitriding, carbonitriding, cyaniding, induction hardening, flame hardening, laser hardening, electron beam hardening methods.

Clad materials: Cladding techniques, roll bonding, explosive welding, extrusion and laser cladding, important cladding materials and applications in nuclear, marine and other technological fields

### **Recommended Books:**

# Curriculum

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1. Engineering Tribology by Gwidon Stachowiak and Andrew W. Batchelor. 4<sup>th</sup> ed. (2013)
2. Handbook of Physical Vapour Deposition (PVD) Processing by Donald Mattox. 2<sup>nd</sup> ed., (2010)
3. Surface Engineering Techniques and Applications: Research Advancements by Loredana Santo (University of Rome "Tor Vergata", Italy) and J. Paulo Davim (University of Aveiro, Portugal) – ed. (2013)
4. Surface Engineering: An Introduction by John B Hudson. Butterworth Heinemann, (2000)
5. DeGarmo's Materials and Processes in Manufacturing by J. T. Black, Ronald A. Kohser. 11<sup>th</sup> ed. (2011)

Journals/Periodicals

World Wide Web

## **MME 406 Bio Materials 2(2,0)**

### **Course Outlines:**

History of biomaterials, introduction to biochemistry, Important material classes.

Biocompatibility, Host reactions to bio implants, Bio-reabsorbable & bio-erodible materials.

Hydrogels & smart polymers (polyurethanes, silicones, fluorinated biomaterials, acrylics).

Cell Biology, Surface properties of materials, Intermolecular forces in biology (Van der waals, Electrostatic, Hydrophobic, steric forces).

Response of materials in human body, effect of mechanical forces on cells & tissues, biomimetic materials, importance of water in biomaterials.

In-vivo testing (animal models), In-vitro testing (tissue compatibility, microscopy of biomaterials, agar diffusion test, direct contact test, extract dilution test).

Biocompatible metals: Ti-based, Stainless Steels, Co-Cr-Mo alloys, nitinol, biomaterials surface & protein, textured & porous materials, Bio active glasses, Bioreabsorbable ceramics, adhesives & sealants

Applications (Orthopedic, Dental, cardiovascular, soft tissue replacement, hard tissue replacement), Drug delivery system (nano-carriers, polymer-drug conjugates, nucleic acids, etc.),

Biomaterial corrosion, blood & materials interaction, tumors associated with biomaterials

### **Recommended books:**

1. Biomaterials Science: An Introduction to Materials in Medicine by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons. 3<sup>rd</sup> ed. (2012)

# Curriculum

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2. Introduction to Biomaterials by sih, D. World Scientific, (2006).
3. An Introduction to Biomaterials by Jeffrey O. Hollinger. 2<sup>nd</sup> ed. CRC Press, (2011)
4. Biomaterials: principles & applications by Joon B. Park, Joseph D. Bronzino. CRC Press (2003)

Journals/Periodicals

World Wide Web

## **MME 407 Vacuum Technology 2(2,0)**

### **Course Outlines:**

Vacuum technology: Different units of measuring pressure vacuum regimes, mean free path, collision frequency. Vacuum pumps: Water pumps, positive displacement pumps, rotary and roots pump, vapour ejector and vapour entrainment pumps, diffusion pump, turbo-molecular pump, ion pumps, sieve pumps, adsorption pumps. Classification and working principles of vacuum measuring devices: Manometers, McLeod gauge, Penning gauge, Pirani gauge. Calculation of vacuum systems, conductance and through put, effective pumping speed, gas flow through pipes and orifices. Sources of leakage, leakage detection and remedies. Application of vacuum in materials processing. Vacuum induction melting, vacuum arc melting. Metal refining in vacuum, degassing in liquid state, vacuum heat treatment, vacuum sintering, vacuum coating, use of vacuum technology in the production of strategic materials. Design of vacuum furnaces. Vacuum Coatings: Introduction, purpose of vacuum coating, process of vacuum coating, vacuum coating system by electro bio-bombardment beating, valves used in vacuum technology.

### **Recommended books:**

1. Vacuum Technology by Alexander Roth. North-Holland, (2007)
2. The Foundations of Vacuum Coating Technology by Mattox, D. M. Noyes Data Corporation/Noyes Publications, (2003)
3. Vacuum Metallurgy by Choudhury, A. ASM Intl, (2000)
4. Vacuum Metallurgy by Inker. O.W. Elsevier, (2001)
5. Vacuum Technology by Alexander Roth. North-Holland, (2007)
6. Vacuum Technology in the Chemical Industry by Wolfgang Jorisch. John Wiley & Sons Inc., (2010)
7. Vacuum technology: practice for scientific instruments by Nagamitsu Yoshimura. Springer, (2008).

Journals/Periodicals

World Wide Web

## Curriculum

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**MME 412 Final Project-II 3(0,3)**

**Pre-requisites:** Final Project-I (MME 411)

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