

# 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 balances three phase system, Earthing of apparatus.

**Transformers:** Basic principle, Ration 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).

#### 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,

## Curriculum

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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 overview of Metallurgical and Materials Engineering, Classification of materials: metals, ceramics, polymers, and composites. Structure-properties relationship, crystal structures and crystalline defects, mechanical properties of materials. An overview of characterization techniques in materials science. Introduction to metal processing techniques: casting, metal working, welding, powder metallurgy, and heat treatment processes. Corrosion and prevention. An introduction to various alloys and phase diagrams. An overview of polymeric and ceramics materials processing techniques. Introduction to electric and magnetic materials, nano, bio, and advance materials.

#### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

### **Recommended Books:**

1. Fundamentals of Materials Science and Engineering by W. D. Callister, D. G. Rethwisch, 10<sup>th</sup> ed. Wiley, (2018).
2. Foundations of Materials Science and Engineering by W. F. Smith, J. Hashemi. 5th ed. Mc Graw Hill (2010)
3. Engineering Materials 1 by D.R.H. Jones and M. F. Ashby. 5<sup>th</sup> ed. Elsevier (2019)
4. Engineering Materials 2 by M. F. Ashby and D.R.H. Jones. 4<sup>th</sup> ed. Elsevier (2012)

### **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

# Curriculum

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## Sura Al-Hujurat

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

*Main Points of discussion:*

- 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)

## 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.

## Curriculum

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*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*

*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

# Curriculum

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## 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
- 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)

# Curriculum

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## **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**

- 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

## Curriculum

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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. Hospital'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.

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.

## Curriculum

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.

### **QT 101 Translation of the Holy Qur'an -I (1,0)**

#### **Week wise Course Contents:**

Week	Details
Week 1	Translation of Part ( <i>Parah</i> ) 1, first ½ portion
Week 2	Translation of Part ( <i>Parah</i> ) 1, second ½ portion
Week 3	Translation of Part ( <i>Parah</i> ) 2, first ½ portion
Week 4	Translation of Part ( <i>Parah</i> ) 2, second ½ portion
Week 5	Translation of Part ( <i>Parah</i> ) 3, first ½ portion
Week 6	Translation of Part ( <i>Parah</i> ) 3, second ½ portion
Week 7	Translation of Part ( <i>Parah</i> ) 4, first ½ portion
Week 8	Translation of Part ( <i>Parah</i> ) 4, second ½ portion
Week 9	<b>Mid semester exam</b>
Week 10	Translation of Part ( <i>Parah</i> ) 5, first ½ portion
Week 11	Translation of Part ( <i>Parah</i> ) 5, second ½ portion
Week 12	Translation of Part ( <i>Parah</i> ) 6, first ½ portion
Week 13	Translation of Part ( <i>Parah</i> ) 6, second ½ portion
Week 14	Translation of Part ( <i>Parah</i> ) 7, first ½ portion
Week 15	Translation of Part ( <i>Parah</i> ) 7, second ½ portion
Week 16	Translation of Part ( <i>Parah</i> ) 8, first ½ portion
Week 17	Translation of Part ( <i>Parah</i> ) 8, second ½ portion
Week 18	<b>End semester exam</b>

#### **List of recommended translations of the Holy Qur'an:**

1. موضح القرآن شاه عبدالقادر دہلوی
2. فتح القرآن
3. فتح محمد جالندھری
4. آسان ترجمہ قرآن
5. احسن البیان
6. سید شبیر حسین
7. آسان ترجمہ قرآن
8. آسان ترجمہ قرآن
9. پیر کرم شاہ الازہری
10. مولانا محمد تقی عثمانی
11. مولانا احمد سعید دہلوی
12. مولانا غلام رسول سعیدی
13. مولانا محمد جونا گڑھی
14. مولانا اشرف تھانوی
15. مولانا عبدالرحمن طاہر
16. ڈاکٹر عبدالرحمن طاہر
17. ڈاکٹر فرحت ہاشمی
18. ڈاکٹر فرحت ہاشمی
19. آسان ترجمہ قرآن
20. آسان ترجمہ قرآن
21. Marmaduke Pickthal
22. Abdullah Yousaf Ali
23. Dr. Mohammad Mahmood Ghali
24. Muhammad Asad
25. The meaning of Glorious Qur'an
26. Qur'an Translation English
27. Qur'an Translation English
28. Qur'an Translation English
29. Qur'an Translation English
30. Qur'an Translation English



# Curriculum

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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.

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.

## Curriculum

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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.

**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 Wiring by Richter and Schwan
3. Wiring Manual by Pak Cables Limited.

# Curriculum

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## **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 Communication by Murphy, Hildebrandt and Thomas. 7<sup>th</sup> Edition
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:**

Short review of methods of statics, Stresses in the member of a structures, Analysis and design, Concept of Stress, Axial Loading: Normal Stress, Centric & Eccentric Loading, Shearing Stress, Bearing Stress in Connections, Stress Analysis & Design Example, Stress in Two Force Members, Stress on an Oblique Plane, Stress Under General Loadings, Factor of Safety, Normal Strain, Stress-Strain Test, Tensile testing machine (operation modes & outputs), Stress-Strain Diagram: Ductile vs. Brittle Materials, Hooke's Law: Modulus of Elasticity, Elastic vs. Plastic Behavior, Fatigue, Static Indeterminacy, Thermal Stresses, Poisson's Ratio, Generalized Hooke's Law, Dilatation: Bulk Modulus, Stress Concentration: Hole & Fillet, Torsional Loads on Circular Shafts, Net Torque Due to Internal Stresses, Axial Shear Components, Shaft Deformations, Torsional Failure Modes, Angle of Twist in Elastic Range, Pure Bending, Symmetric Member in Pure Bending, Bending Deformations, Stress and Strain Due to Bending, Deformations in a Transverse Cross-Section, Bending of Members Made of Several Materials, Reinforced Concrete Beams, Shear and Bending Moment Diagrams, Relations Among Load, Shear, and Bending Moment, Design of Prismatic Beams for Bending, Singularity Functions used to determine Shear and Bending Moment, Mohr's Circle.

## Curriculum

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### **Recommended Books:**

1. Mechanics of Materials by Beer and Johnston. 8<sup>th</sup> ed. McGraw Hill Inc., (2020)
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)

### **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.

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. 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.

### **CS-103 & CS-103L Introduction of computer programming for data science 3(3,0)**

#### **Course Outlines:**

This course serves as an introduction to computer programming. We will study and implement the standard introductory topics of Python. Besides that, we will learn the applications of programming to data science.

#### **Recommended Books:**

## Curriculum

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1. Paul Deitel & Harvey Deitel, “Intro to Python® for Computer Science and Data Science: Learning to Program with AI, Big Data and the Cloud”, Pearson Education, Inc. 2020

### Optional Books

1. Wes McKinney, “Python for Data Analysis”, O’Reilly Media, Inc, 2018
  2. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly Media, Inc, 2017
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# Curriculum

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## **THIRD SEMESTER**

### **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, Phase diagrams.

#### **Recommended Books:**

1. Metallurgical Thermodynamics Kinetics And Numericals by Dutta S.K. (Author), Lele A.B. (2017)
2. An introduction to Chemical Metallurgy by R. H. Parker. 2<sup>nd</sup> ed. Elsevier, (2013)
3. Phase Transformation in Metals and Alloys by D.A. Porter and K.E. Easterling. 4<sup>th</sup> ed. CRC Press,, (2021)

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

#### **Course Outlines:**

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

##### **1) Al-Our'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

## Curriculum

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- 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*
- *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. Textural 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

## Curriculum

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- 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
- 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.

### 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*



## Curriculum

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*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 iIsrail*: 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
- 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

## Curriculum

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- Pakistan and International Organizations: UN, OIC, SAARC, ECO and SCO
- Economical and defensive planning (Nuclear policy)

### **MA 240 & 240L 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.

### **MME 212 & 212L Inspection and Quality Assurance 4(3,1)**

#### **Course Outlines:**

Introduction to inspection and quality assurance. Hardness Testing (Arbitrary or indentation hardness, Rebound of dynamic hardness, Scratch hardness, Abrasion test, File test. Macrohardness Testing (Brinell, Rockwell), Microhardness Testing (Knoop, Vicker, Ultrasonic).

Tensile testing (Engineering Stress Strain Curve and its explanation. Resilience, Toughness, True-stress-strain concepts, ductile & brittle fracture, Power law or Holloman's relationship, Effect of strain rate & temperature, Compression test.

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

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

Non-destructive testing (Visual Testing, Leak Testing, Radiographic method, Magnetic particle method, Magnetic flux leakage, Eddy Current Testing, Dye penetrant method, ultrasonic method, Phase array testing, Thermal/infrared testing, Vibration Analysis, Boroscopy.

## Curriculum

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Reliability and maintainability, inspection of different types of materials and products for evaluation. Introduction to standards. Familiarization of standards for testing of materials, ASTM, BS, JIS GOST and ISO. Pakistan Standards.

### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

### **Recommended Books:**

1. Inspection of Metals: Understanding the Basics by F. C. Campbell, ASM International (2015)
2. Mechanical Metallurgy by George E. Dieter. McGraw-Hill Book Company (UK) Ltd., (2002)
3. Introduction to Non-Destructive Testing, a training guide by Paul E. Mix. 2<sup>nd</sup> ed. Wiley, (2005)

### **MME 213 Extractive Metallurgy 2(2,0)**

#### **Course Outlines:**

Brief history of ferrous and non-ferrous metals, Sources of ferrous/non-ferrous metals, Mineral Processing of ores. Principles of metals extraction: Thermodynamic principles, homogeneous and heterogeneous reactions, Ellingham diagrams, kinetic principles, principles of electro-chemistry. General methods of extraction: pyro-metallurgy, hydrometallurgy, and electrometallurgy. Charge and energy calculations. General methods of refining.

Extraction of metals from oxide sources: Basic approaches and special features of specific extraction processes, extraction of metals such as magnesium, aluminum, tin, chromium 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. 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. Principles of Extractive Metallurgy by T. Rosenqvist. 2<sup>nd</sup> ed. (reprinted), McGraw Hill, New York, (2004)

### **MME 214 Industrial Safety and Environmental Engineering 2(2,0)**

#### **Course Outlines:**

Industrial safety management, understanding of accidents, accident prevention, accident control/loss control, its reporting and investigation. Safety against fire, electrical equipment, boilers, material handling/storage, and production operation. Process safety management. Understanding and analysis of process hazards and hazard communication. Chemical inventory record. Industrial hygiene and workers

## Curriculum

protection. Personal protective equipment (PPE) and their selection criteria. Environment management. Introduction to Pakistan Environment Protection Act 1997 and National Environmental Quality Standards. Key elements of ISO 14000.

### Recommended Books:

1. Occupational Safety and Health in the Emergency Services by James Angle. 4<sup>th</sup> ed, Jones and Barlett Learning, (2015)
2. Safety and Environmental Management by Dr. Della-Giustina. 2<sup>nd</sup> ed, Government Institutes (2007)
3. Occupational Safety & Health Management by Thomas J. Anton. 2<sup>nd</sup> ed, New York, McGraw Hill, (1989)

### QT 201 Translation of the Holy Quran-II 1(1,0)

#### Week wise Course Contents

Week	Details
Week 1	Translation of Part ( <i>Parah</i> ) 9, first ½ portion
Week 2	Translation of Part ( <i>Parah</i> ) 9, second ½ portion
Week 3	Translation of Part ( <i>Parah</i> ) 10, first ½ portion
Week 4	Translation of Part ( <i>Parah</i> ) 10, second ½ portion
Week 5	Translation of Part ( <i>Parah</i> ) 11, first ½ portion
Week 6	Translation of Part ( <i>Parah</i> ) 11, second ½ portion
Week 7	Translation of Part ( <i>Parah</i> ) 12, first ½ portion
Week 8	Translation of Part ( <i>Parah</i> ) 12, second ½ portion
Week 9	<b>Mid Semester Exam</b>
Week 10	Translation of Part ( <i>Parah</i> ) 13, first ½ portion
Week 11	Translation of Part ( <i>Parah</i> ) 13, second ½ portion
Week 12	Translation of Part ( <i>Parah</i> ) 14, first ½ portion
Week 13	Translation of Part ( <i>Parah</i> ) 14, second ½ portion
Week 14	Translation of Part ( <i>Parah</i> ) 15, first ½ portion
Week 15	Translation of Part ( <i>Parah</i> ) 15, second ½ portion
Week 16	Translation of Part ( <i>Parah</i> ) 16, first ½ portion
Week 17	Translation of Part ( <i>Parah</i> ) 16, second ½ portion
Week 18	<b>End Semester Exam</b>

#### List of recommended translations of the Holy Qur'an:

1. حافظ 3. ترجمہ قرآن مجید فتح محمد جالندھری
2. فتح القرآن شاه عبدالقادر دہلوی 1. موضح القرآن نذر احمد
6. ترجمہ ضیا القرآن مولانا محمد جونا گڑھی 5. احسن البیان سید شبیر حسین 4. آسان ترجمہ قرآن پیر کرم شاہ الازہری
9. کشف الرحمن 8. ترجمہ قرآن مولانا اشرف تھانوی 7. آسان ترجمہ قرآن احمد سعید دہلوی
12. معانی القرآن ڈاکٹر عبدالرحمن طاہر 11. مصباح القرآن 10. ترجمہ تبيان القرآن، مولانا غلام رسول سعیدی
- سید 15. مقبول القرآن ڈاکٹر فرحت ہاشمی 14. قرآن مجید، لفظی ترجمہ سید ابو الاعلیٰ مودودی 13. ترجمہ قرآن مقبول احمد دہلوی
16. آسان ترجمہ قرآن Marmaduke Pickthal 17. The meaning of Glorious Qur'an محمد ظفر
18. Qur'an Translation English Abdullah Yousaf Ali
19. Qur'an Translation English Dr. Mohammad Mahmood Ghali

## Curriculum

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20 .*Qur'ān* Translation English

Muhammad Asad

# Curriculum

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## **FOURTH SEMESTER**

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

**Pre-Requisite: MME 202 Applied Thermodynamics**

#### **Course Outlines:**

Introduction to Physical Metallurgy; structure properties relationship; Atomic and crystalline structure; crystal symmetry; crystallographic defects; Allotropy and polymorphism; Miller indexing system; stacking of planes; Atomic, linear and planar densities; concept of Interstitial Voids.

Solidification (Homogeneous and heterogeneous); Nucleation and growth; Grain-boundaries and grain structure; Role of Metallurgical microscope in the analysis of microstructure; theory of etching and concept of grain boundary energy.

Phase-rule; Solid solutions; limits of solid solubility; types of Compounds; different types of binary phase diagrams: Isomorphous system, Eutectic and eutectoid reactions, coherent/in-coherent precipitates, Peritectic and peritectoid reactions; Ordered and disordered solutions; Iron-Iron carbide system, microstructure and properties of plain carbon steels and cast-irons; microstructure of common copper-base and aluminum-base alloys.

#### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

#### **Recommended Books:**

1. Physical Metallurgy: Principles and Design by Gregory N. Haidemenopoulos. CRC Press, (2018)
2. Physical Metallurgy: Metals, Alloys, Phase Transformations by Vadim M. Schastlivtsev, Vitaly I. Zel'dovich, Walter de Gruyter GmbH (2022)
3. Materials Science and Engineering: An Introduction by Williams D. Callister, 10th Edition, Wiley (2018)

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

**Pre-Requisite: MME 213 Extractive Metallurgy**

#### **Course Outlines:**

A brief review of solution thermodynamics. Mineral processing of iron ores, agglomeration processes for iron ores, blast furnace process and reactions, blast furnace gas cleaning system and blast furnace stoves. Recent developments in BF process. Alternate iron making processes. Introduction to steelmaking fundamentals, oxidation reactions in steelmaking processes. Primary steelmaking processes: basic oxygen furnace (BOF) and electric arc furnace (EAF), design and process description, latest trends in BOF and EAF Processes. Induction furnace, design, and process description. Secondary steelmaking processes: argon purging, ladle de-oxidation, degassing, and emerging ladle metallurgy processes. Continuous casting of steel. Charge calculations for iron and steel making processes. Environmental impacts of steel industry. Concepts of standards and specification of ferrous alloy systems.

#### **Recommended Books:**

## Curriculum

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1. Basic Concepts of Iron and Steel Making by S. K. Dutta and Y. B. Chokshi, (eBook), Springer Nature, (2020).
2. An Introduction to Modern Iron Making by R.H. Tupkary and V.R. Tupkary. 4<sup>th</sup> ed. Khana Publications India, (2013).
3. An Introduction to Modern Steel Making by R. H. Tupkary and V. R. Tupkary. 7<sup>th</sup> ed. Khana Publications India, (2008).

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

### **HU 221 Technical Writing & Presentation Skills 1(0,1)**

#### **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 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.

# Curriculum

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## **Methodology:**

Teaching of concepts shall take place through lectures, during which analysis of technical examples will help students to grasp the concepts being taught. To check and reinforce understanding, exercises will follow each new concept. The instructor must incorporate presentation into their writing process.

## **Recommended Books:**

1. Basic Business Communication by Raymond V. Lesikar and Marie E. Flatley, McGraw Hill (2001).
2. Technical Communication. Process and Product by Gerson & Gerson. Pearson Education Inc., (2017)
3. Technical Writing Essentials: Introduction to professional Communications in Technical fields by Suzan Last, Candice Naveu and Monika Smith (2019)
4. Basic Communication Skills for Technology by Andrea J. Rutherford, Pearson (2000)

## **MME 215 & MME 215L Ceramic Materials 4(3,1)**

### **Course Outlines:**

Introduction to various classes of ceramics, Traditional versus advance ceramics, History, applications. Bonding Characteristics of Ceramics, Crystal Structures–Binary ionic compounds, Composite crystal structure, Covalent Ceramics, Pauling's Rules, Silicate Structures.

Ceramics as refractories in metallurgical industries, their types and classifications. Production of refractory bricks and other shapes of traditional ceramics, structural changes during processing/sintering of refractories. Selection 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 – uni-, bi-axial and cold & hot isostatic pressing, injection molding, slip casting, tape-casting.

Sintering and sintering theory of ceramics. Defects in Ceramics, Types 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. Fundamentals of Ceramics by M W Barsoum. 2<sup>nd</sup> ed. CRC Press, (2020)
2. Modern Ceramic Engineering: Properties, Processing, and Use in Design by David Richerson. 4<sup>th</sup> ed. CRC Press, (2018)
3. Ceramic and Glass Materials: Structure, Properties and Processing by James F. Shackelford (Editor), Robert H. Doremus. 1<sup>st</sup> ed. Springer, (2008)



# Curriculum

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## **MME 216 Mechanical Behavior of Engineering Materials 3(3,0)**

**Pre-Requisite: MME 104 Mechanics of Materials**

### **Course Outlines:**

A review of the structure of materials and crystalline imperfections. Elasticity (review of stress and strain concepts, Hooke's law, Elastic strain energy); Plasticity (Analysis of Stress-strain behavior, Yielding criteria of Metals and Hardness); Notches (Stress concentration factor, Neuber's rule, Tensile testing of notched specimens).

Fracture Mechanics (Fracture modes; Linear elastic fracture mechanics: stress intensity factor and fracture toughness); Theoretical cohesive strength and Griffith criteria; Plain strain toughness testing; crack tip opening displacement (CTOD).

Plastic deformation and role of Dislocations; types of dislocations; Slip systems; Critical resolved shear stress; Taylor factor; Dislocation interaction; Thermally activated processes; Intersection of dislocations. Ductile-brittle transition. Strengthening Mechanisms. Severe plastic deformation. Fracture behavior of metallic materials (ductile, brittle fractures); different types of embrittlements; Stress-corrosion cracking. Fatigue and creep deformation and fracture (Structural changes; theories and mechanism of crack initiation and propagation; Materials' selection).

Mechanical behavior of thin films and coatings; Mechanical behavior of Polymers, Ceramics, glasses and composites; Weibull Modulus

### **Recommended Books:**

1. Mechanical Behavior of Material by Norman E. Dowling (Author), Stephen L. Kampe (Author), Milo V. Kral, Global Edition 5th Edition, Pearson (2019)
2. Mechanical Behaviour of Engineering Materials: Metals, Ceramics, Polymers by Joachim Roesler, Harald Harders, Martin Baeker. Springer, (2007)
3. Mechanical Metallurgy by George E. Dieter. SI Metric ed. McGraw Hill Inc., (2002)

# Curriculum

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## **FIFTH SEMESTER**

### **MME 301 & 301L Electrical and Magnetic Materials 3(2,1)**

#### **Course Outlines:**

Classification and concept of Electrical and Electronic Materials. Metallic materials and their electrical properties. Semiconductor materials and their electrical properties. Semiconductor devices. Ceramic materials used in electronic applications.

Magnetic materials and their classification. Magnetization curve, hysteresis loop. Types of magnetic behavior. Ferromagnetic domains. Experimental evidence for domains. Domain wall motion. Hindrances to wall motion. 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.

#### **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. 10th edition, Wiley (2018)
2. Foundations of Materials Science and Engineering by William Smith, Javed Hashemi. 5th ed. (2009)
3. The Science and Engineering of Materials by Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright. 6th ed. (2010)

### **QT 301 Translation of the Holy Quran-III 1(1,0)**

#### **Week wise Course Contents**

Week	Details
Week 1	Translation of Part ( <i>Parah</i> ) 17, first ½ portion
Week 2	Translation of Part ( <i>Parah</i> ) 17, second ½ portion
Week 3	Translation of Part ( <i>Parah</i> ) 18, first ½ portion
Week 4	Translation of Part ( <i>Parah</i> ) 18, second ½ portion
Week 5	Translation of Part ( <i>Parah</i> ) 19, first ½ portion
Week 6	Translation of Part ( <i>Parah</i> ) 19, second ½ portion
Week 7	Translation of Part ( <i>Parah</i> ) 20, first ½ portion
Week 8	Translation of Part ( <i>Parah</i> ) 20,
Week 9	Mid Semester Exam
Week 10	Translation of Part ( <i>Parah</i> ) 21, first ½ portion
Week 11	Translation of Part ( <i>Parah</i> ) 21, second ½ portion
Week 12	Translation of Part ( <i>Parah</i> ) 22, first ½ portion
Week 13	Translation of Part ( <i>Parah</i> ) 22, second ½ portion
Week 14	Translation of Part ( <i>Parah</i> ) 23, first ½ portion
Week 15	Translation of Part ( <i>Parah</i> ) 23, second ½ portion
Week 16	Translation of Part ( <i>Parah</i> ) 24, first ½ portion
Week 17	Translation of Part ( <i>Parah</i> ) 24, second ½ portion
Week 18	End Semester Exam

## Curriculum

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### List of recommended translations of the Holy *Qur'ān*:

- حافظ 3. ترجمه قرآن مجید فتح محمد جالندهری 2. فتح القرآن شاه عبدالقادر دہلوی 1. موضح القرآن نذر احمد
6. ترجمہ ضیا القرآن مولانا محمد جونا گڑھی 5. احسن البیان سید شبیر حسین 4. آسان ترجمہ قرآن پیر کرم شاہ الازہری
- مولانا 9. کشف الرحمن 8. ترجمہ قرآن، مولانا اشرف تھانوی مولانا محمد تقی عثمانی 7. آسان ترجمہ قرآن احمد سعید دہلوی
- دارالسلام 12. معانی القرآن 11. مصباح القرآن، ڈاکٹر عبدالرحمن طاہر 10. ترجمہ تبيين القرآن، ولانا غلام رسول سعیدی
- سید ڈاکٹر فرحت ہاشمی 15. مقبول القرآن 14. فہم القرآن، لفظی ترجمہ محمد ظفر
17. The meaning of Glorious *Qur'ān* Marmaduke Pickthal
18. *Qur'ān* Translation English Abdullah Yousaf Ali
19. *Qur'ān* Translation English Dr. Mohammad Mahmood Ghali
20. *Qur'ān* Translation English Muhammad Asad

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

#### **Course Outlines:**

Pressure Measurement: Pressure units, Manometers, Diaphragms, Bellows, Bourden Tubes, Secondary transducers (strain gauge and LVDT).

Temperature Measurement: Introduction and units. Liquid Expansion Thermometers (Mercury in Glass, Liquid in glass), Bimetallic strip Thermometers, Pressure-Spring thermometers, Resistance Temperature Detectors, thermistors, Thermocouples. Pyrometers.

Level Measurement: Differential Pressure, Displacer, Bubbler, Capacitance, Conductance, Ultrasonic,

Flow Measurement: Head type flow meters (Orifice plate, Venturi tube, pilot tube) Rotameter, Anemometers, Electromagnetic flow meters, Mechanical Meter (turbine type), Ultrasonic type flowmeter. Weight, force, stress, and strain measurement.

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

#### **Recommended books:**

1. Fundamentals of Industrial Instrumentation and Process Control by William Dunn. 2<sup>nd</sup> edition, McGraw Hill Professional, (2018)
2. Process Control Instrumentation Technology by Curtis D. Johnson. Pearson/Prentice Hall, (2006)
3. Fundamentals of Instrumentation by Delmer Cengag. Learning, (2008)

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

**Pre-Requisite: MME 211 Physical Metallurgy**

#### **Course Outlines:**

Introduction to characterization techniques and their application in Materials science and Engineering Production and absorption of X-rays; use of filters; X-ray diffraction and Bragg's law; structure factor calculations; diffraction methods; Debye-Scherrer camera; Laue back-reflection; and rotating-crystal

## Curriculum

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method. XRD spectrum and its Indexing; Precise lattice parameter determination; Particle size and micro/macro strains calculations. Chemical analysis by X-ray fluorescence.

Stereographic projections; orientation of crystal with respect to a reference; rotation of crystal around an axis; planes of a zone. Crystal structure determination; single crystals orientation; pole figures; Applications of X-ray diffraction.

Scanning electron microscope (SEM); construction and working principle; interaction of electrons with matter; modes of operation; image formation of plane and fractured surfaces. Energy Dispersive X-rays and wavelength dispersive X-rays systems;

Electron diffraction and basics of transmission electron microscopy (TEM); Image formation; resolving power and 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 spectroscopy etc.

### **Recommended Books:**

1. Materials Characterization: Modern Methods and Applications Edited By N. (Mohan) Ranganathan, 1<sup>st</sup> Edition, Jenny Stanford Publishing (2016)
2. Characterization of Materials by Elton N. Kaufmann. 3 Volume Set, Wiley, (2012)
3. X-Ray Diffraction by B. D. Cullity. 3<sup>rd</sup> ed. Prentice Hall, (2001)

### **MME 313 & 313L Foundry Engineering 4(3,1)**

#### **Course Outlines:**

Introduction to Foundry Engineering and Practice; Scope and importance; Foundry industry in Pakistan; Types and different sections of a foundry; foundry tools, machines and types of furnaces; Furnace Charges and Calculations.

Pattern; pattern design, materials and pattern making techniques. Selection, properties and testing of suitable molding and core materials. Molding Processes: Green sand and dry sand molding; Shell molding; Core sand molding; CO<sub>2</sub> molding; water glass molding; resin sand molding; alpha set and no bake process; molding sand properties and testing. Pit and floor molding; Loam molding; Molding machines and equipment; Mold coatings; 3D printing in sand molding. Molding Cores: Ingredients and Properties of core sand; Binders; core design, coatings; baking and finishing; core testing.

Mold designing: Design and essentials of gating system; design of pouring cups sprue; runners types and gates; Gating ratio; riser shape, location and design; pressure-less and pressurized gating systems

Other foundry techniques: Plaster casting; Investment casting; low pressure die casting; high pressure die casting; Permanent mold casting; Centrifugal casting; Slush casting; Ingot as casting; Gravity die casting Ferrous and non-ferrous casting techniques; selection and control of melting processes; Casting and fettling operation; Metal gas interaction; Solidification of pure metal and alloys; Solidification in a mold; Directional and non-directional solidification

Casting Defect types; remedies; inspection of castings; Role of casting simulations to control defects and minimize losses. Casting Cleaning methods

#### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

### **Recommended Books:**

## Curriculum

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1. Principles of Metal Casting by Mahi Sahoo, Sudhari "Sam" Sahu, McGraw Hill (2014)
2. Complete Casting Handbook: Metal Casting Processes, Metallurgy, Techniques and Design by John Campbell, 2nd Edition, Butterworth Heinemann (2015)
3. Principles of Foundry Technology by P L Jain. 8<sup>th</sup> ed. Tata McGraw-Hill, (2008)

### **MME 314 & 314L Polymeric Materials 4(3,1)**

#### **Course Outlines:**

A review of organic chemistry and Introduction to polymeric materials. Classification of polymeric materials. Molecular structure of polymers.

Principles, kinetics and mechanisms of polymerization (addition and condensation). Systems of polymerization: Homogenous and Heterogeneous. Techniques of polymerization: Bulk technique, Solution technique, Suspension technique, Emulsion technique. Different Additives for polymers: Fillers, Plasticizers, Stabilizers, Coloring matters, Lubricants, Flow promoters, Crosslinking agents.

Glass transitioning temperature. Polymers' crystallinity. Liquid crystal polymers.

Visco-elastic behavior of polymeric materials.

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

Fabrication techniques for thermoplastics and thermosets. Polymeric composites.

#### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

#### **Recommended Books:**

1. Polymer Science and Technology by Joel R. Fried. 3<sup>rd</sup> ed. Prentice Hall, (2014)
2. Foundations of Materials Science and Engineering by William F. Smith, Javaid Hashemi. 5th ed. (2009)
3. Fundamentals of Materials Science and Engineering by William D. Callister, David G. Rethwisch: An Integrated Approach. 5<sup>th</sup> ed. Wiley (2018)

### **MME 325 Advanced Ceramics 3(3,0)**

**Pre-requisite: MME 215 Ceramic Materials**

#### **Course Outlines:**

Review of ceramic fundamentals and introduction to advanced ceramics; Engineering applications of ceramics at room and high temperatures. Oxide and non-oxide ceramics; their chemical formulae; crystal and defect structures; non-stoichiometry and typical properties; Microstructure-properties relationship, Preparation of single crystal, thick and thin film ceramics.

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

Bio-medical applications of ceramic materials. Ceramics for energy and environment technologies – an introduction including fuel cell, Thermoelectrics etc. Ferroelectric, Piezoelectric and Pyro-electric ceramics for insulating, semi-conducting and super-conducting applications. Li-Ion Batteries. Smart and nano-ceramics.

# Curriculum

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## **Recommended Books:**

1. Advanced Ceramics for Versatile Interdisciplinary Applications by Editors: Shiv Singh, Pradip Kumar, D.P. Mondal, Elsevier (2022)
2. Fundamentals of Ceramics by M W Barsoum. 2nd ed. CRC Press, (2020)
3. Electroceramics by A.J. Moulson. Wiley, (2003)

# Curriculum

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## **SIXTH SEMESTER**

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

**Pre-requisite: MME 211 Physical Metallurgy**

#### **Course Outlines:**

Thermodynamics of Phase Transformation: Gibbs free energy and phase equilibrium. Free-energy changes in single component system, Clausius Clapeyron equation. Gibbs free energy changes in binary alloys, Free energy of mixing, Ideal and real solutions, Ordered-disordered phases.  $G$  vs  $X_B$  curves and phase diagrams, Gibbs phase rule. Driving Force for diffusion, free energy and diffusion, Fick's first and second laws of diffusion. Interfaces: Structure and types of interfaces, free energy of grain boundary, Nucleation and Growth: Nucleation of precipitates from a supersaturated matrix, driving force for nucleation. Diffusion and diffusion less transformations: Kinetics and mechanisms of Austenitic, Pearlitic, Bainitic and martensitic transformations. Time temperature transformation and continuous cooling diagrams. Heat Treatment processes: Annealing, normalizing, and quenching processes. Hardenability measurement techniques. Surface hardening methods. Precipitation hardening (ageing). Heat treatment of die and tool steels, heat treatment of cast-irons, heat treatment of common non-ferrous alloys.

#### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

#### **Recommended Books:**

1. Heat Treatment: Principles and Techniques by T.V. Rajan, C.P Sharma, Ashok Sharma. 2<sup>nd</sup> ed. Prantice Hall, India, (2011)
2. Phase Transformation in Metals and Alloys by D. A. Porter, K. E. Easterling and M. Y. Sherif . 3<sup>rd</sup> ed., CRC press (2009)
3. Physical Metallurgy: Metals, Alloys, Phase Transformations by Vadim M. Schastlivtsev, Vitaly I. Zel'dovich, Walter de Gruyter GmbH (2022)

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

#### **Course Outlines:**

Introduction to Joining Processes and Classification.  
Fusion Welding: Arc Welding Processes; Resistance Welding processes; Special Welding processes  
Solid State Welding: Brazing, Soldering, Adhesive Bonding, Friction stir welding etc.  
Metallurgy of Welding: Weld-ability 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

# Curriculum

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## **Recommended Books:**

1. Welding Principles and Applications, Larry Jeffus, 9th ed. Cengage Learning; 9th edition, (2020)
2. Principles of Welding: Processes, Physics, Chemistry and Metallurgy, Robert W. Messler, Wiley & Sons, (2015)
3. Joining of Materials and Structures: From Pragmatic Process to Enabling Technology, Robert W. Messler. 1st ed. Butterworth-Heinemann, (2004)

## **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. Operations Engineering and Management: Concepts, Analytics and Principles for Improvement by Seyed M. R. Iravani, 1<sup>st</sup> edition, McGraw Hill (2020)
2. Production and Operations Management by Keith Lockyer. Pitman, ELBS ed., (2000)
3. Financial Management by Dr. F. C. Sharma, , C S Rachit Mittal, SPBD Publications (2021)

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

**Pre-requisite: MME 216 Mechanical Behavior of Engineering Materials**

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

Introduction to computational material science and engineering

Introduction to modelling and simulation software (Abaqus / Solidworks); 3D part and assembly modelling, finite element analysis; stress analysis using finite element modeling.

1D Structural Analysis (Truss Elements – Overhead Hoist); 3D Mechanical (Elastic/Plastic) Analysis; deformation of basic structure (Cantilever Beam); 3D Mechanical (Elastic) Analysis; deformation of



## Curriculum

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mechanical parts (Connecting Lug); 2D Heat Transfer + Mechanical Analysis (Plane Stress/Strain) (2D Trapezoidal Plate); Tensile Test – Axisymmetric, 2D or 3D – Elastic, Elasto-plastic with/without damage (Tensile Test of a Ductile Material); Contact analysis including rigid and deformable bodies (3 Points Bend Test); Modelling of elastic properties; plastic deformation and mechanical behavior of engineering materials. Data analysis and plotting.

### **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. An Introduction to Computer Simulation by M.M. Wolfson, G.J. Pert. Oxford, (1999)

### **MME 315 Powder Metallurgy 2(2,0)**

#### **Course Outlines:**

Introduction to powder metallurgy, Applications of powder metallurgy. Advantages and design limitations of powder metallurgy

Powder particles sampling, dispersion & de-agglomeration; Sieve and microscopic analysis; sedimentation; laser light; particle size distributions; data presentation

Characterization of powders: microstructure; particle shape; pycnometer; surface area test; internal structure and chemistry

Production of powders: mechanical methods; electrolytic methods; Atomization techniques; chemical methods

Powders modification and handling; mixing and blending; different lubricants and binders; Powders molding, shaping and compaction (cold and hot compacting methods physical characteristics of powder compacts, compaction defects).

Sintering theory and practices, solid state and liquid phase sintering, modern sintering techniques, sintering atmospheres, thermodynamics of sintering.

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

### **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)

### **MME 316 & MME 316L Corrosion and Corrosion Control 4(3,1)**

#### **Course Outlines:**

Introduction to Corrosion – Electrochemical Nature; Electrochemical cell and 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.

## Curriculum

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Corrosion Kinetics; Polarization; different types of corrosion and their control.

Passivity; Cathodic protection & design of CP system; Anodic Protection.

Electrochemical parameters & their use in corrosion studies.

Corrosion Prevention Methods (Corrosion control) by: Inhibition, Coatings, Corrosion testing through weight loss and electrochemical methods. Selection of materials

Introduction to API methods of Corrosion evaluation.

### **Lab Outlines:**

Lab Manuals will be available in the concerned laboratory

### **Recommended books:**

1. Corrosion Science and Engineering by Pietro Pedferri, Springer link (2018)
2. Corrosion Engineering by Mars G. Fontana. 3<sup>rd</sup> ed. Tata McGraw-Hill, (2005)
3. API-571 Document.

# Curriculum

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## SEVENTH SEMESTER

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

**Pre-requisite: MME 313 Foundry Engineering**

#### Course Outlines:

Freezing of pure metals. **Nucleation and growth in alloys.** Freezing patterns in metals and alloys. **The effects of mold material and alloy composition upon freezing pattern.** Centerline feeding resistance. **The rate of solidification.**

Segregation and its types, Solidification Structures. Shrinkage & its distribution, Gas porosity. **Use of Chills in casting.** Linear contraction, hot tearing, Cold cracking, Residual stress. Fluidity and its measurements (Factors Affecting Fluidity; Pouring Time and Cross Sectional area of ingates; Chvorinov rule; critical velocity and critical height; Effect of surface tension and impurities; Determining fill time required for a casting; Sievert's law)

Metallurgy, design and production of important alloys (e.g., cast irons, alloy steels, aluminum, copper, Titanium and super alloys etc.)

#### Lab Outlines:

Lab Manuals will be available in the concerned laboratory

#### Recommended Books:

1. Principles of Metal Casting by Mahi Sahoo, Sudhari "Sam" Sahu, McGraw Hill (2014)
2. Complete Casting Handbook: Metal Casting Processes, Metallurgy, Techniques and Design by John Campbell, 2nd Edition, Butterworth Heinemann (2015)
3. Principles of Foundry Technology by P L Jain. 8<sup>th</sup> ed. Tata McGraw-Hill, (2008)
4. New Trends in Alloy Development, Characterization and Application by Zaki Ahmad, Intechopen Publishing (2105)

### QT 401 Translation of the Holy Quran-IV 1(1,0)

#### **Week wise Course Contents**

Week	Details
Week 1	Translation of Part ( <i>Parah</i> ) 25, first ½ portion
Week 2	Translation of Part ( <i>Parah</i> ) 25, second ½ portion
Week 3	Translation of Part ( <i>Parah</i> ) 26, first ½ portion
Week 4	Translation of Part ( <i>Parah</i> ) 26, second ½ portion
Week 5	Translation of Part ( <i>Parah</i> ) 27, first ½ portion
Week 6	Translation of Part ( <i>Parah</i> ) 27, second ½ portion
Week 7	Translation of Part ( <i>Parah</i> ) 28, first ½ portion
Week 8	Translation of Part ( <i>Parah</i> ) 28, second ½ portion
Week 9	<b>Mid Semester Exam</b>
Week 10	Translation of Part ( <i>Parah</i> ) 29, first ¼ portion
Week 11	Translation of Part ( <i>Parah</i> ) 29, second ¼ portion
Week 12	Translation of Part ( <i>Parah</i> ) 29, third ¼ portion
Week 13	Translation of Part ( <i>Parah</i> ) 29, fourth ¼ portion
Week 14	Translation of Part ( <i>Parah</i> ) 30, first ¼ portion

## Curriculum

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Week 15	Translation of Part ( <i>Parah</i> ) 30, second ¼ portion
Week 16	Translation of Part ( <i>Parah</i> ) 30, third ¼ portion
Week 17	Translation of Part ( <i>Parah</i> ) 30, fourth ¼ portion
Week 18	<b>End Semester Exam</b>

### List of recommended translations of the Holy *Qur'ān*:

- حافظ 3. ترجمہ قرآن مجید فتح محمد جالندھری 2. فتح القرآن شاہ عبدالقادر دہلوی 1. موضح القرآن نذر احمد
6. ترجمہ ضیا القرآن مولانا محمد جونا گڑھی 5. احسن البیان سید شبیر حسین 4. آسان ترجمہ قرآن پیر کرم شاہ الازہری
9. کشف الرحمن 8. ترجمہ قرآن , مولانا اشرف تھانوی مولانا محمد تقی عثمانی 7. آسان ترجمہ قرآن احمد سعید دہلوی
12. معانی القرآن 11. مصباح القرآن, ڈاکٹر عبدالرحمن طاہر 10. ترجمہ تبيان القرآن , ولانا غلام رسول سعیدی
- سید ڈاکٹر فرحت ہاشمی 15. مقبول القرآن 14. فہم القرآن، لفظی ترجمہ محمد ظفر
17. The meaning of Glorious *Qur'ān* Marmaduke Pickthal
18. *Qur'ān* Translation English Abdullah Yousaf Ali
19. *Qur'ān* Translation English Dr. Mohammad Mahmood Ghali
20. *Qur'ān* Translation English Muhammad Asad

### **MME 426 Metal Working and Removal Processes 3(3,0)**

**Pre-requisite: MME 216 Mechanical Behavior of Engineering Materials**

#### **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.

Machining (Turning), Vertical and Horizontal Milling, Friction stir processing,

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

#### **Recommended Books:**

1. Manufacturing Processes for Engineering Materials by Serope Kalpakjian. 6<sup>th</sup> ed. Pearson, (2017)
2. Introduction to Manufacturing Processes by Mikell P. Groover. Wiley (2011)
3. Mechanical Metallurgy by George E. Dieter. SI metric edition. McGraw Hill, (2002)

### **MME-Elective-01 (Engineering Elective 01) 2(2,0)**

### **MME-Elective-02 (Engineering Elective 02) 2(2,0)**

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

# Curriculum

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## **EIGHTH SEMESTER**

### **MME 403 & MME 403L Composite 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 and interface developments, Manufacturing of PMC's (Polymeric Matrix Composites), MMCs (Metal Matrix Composites) and CMCs (Ceramic Matrix Composites).  
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. Introduction to Composite Materials Design by Ever J. Barero. 3rd ed. (2018)
2. Principles of Composite Material Mechanics by Ronald F. Gibson. 4th ed. (2016)
3. Composite Materials by Deborah D L Chung. Springer, (2010)

### **MME-Elective-03 (Engineering Elective 03) 2(2,0)**

### **MME-Elective-04 (Engineering Elective 04) 2(2,0)**

### **MME-Elective-05 (Engineering Elective 05) 2(2,0)**

### **MME-Elective-06 (Engineering Elective 06) 2(2,0)**

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

**Pre-requisite: MME 411 Final Project-I**

# Curriculum

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## **Course Contents of Engineering Elective Courses to be offered in final year:**

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

#### **Course Outlines:**

Introduction of nuclear energy, Nuclear fission reaction, Breeding ratio, breeding gain.

Classification of nuclear fission reactors, Gas cooled reactors, Light water reactors, Heavy water reactors, Liquid metal fast breeder reactors.

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

Crystal imperfections or defects, Radiation effects or damages by fast neutron, irradiation effect on nuclear, physical, and thermal properties, Irradiation effect on mechanical properties, Creep, Fatigue, and Corrosion.

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. Structural Materials (cladding), Moderator, Reflector, Blanket and Coolant Materials

Metallic uranium as fuel, Ceramics uranium fuels, Plutonium fuel, Thorium as fuel.

#### **Recommended Books:**

1. Nuclear Material Science by Karl Whittle. IOP Science (2020)
2. Nuclear Materials by Hemsworth. Nova science PUB inc. (2011)
3. Introduction to Nuclear Reactor Theory by J. Lemarsh. Addison-Wesley, (2002)

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

#### **Course Outlines:**

Overview of Nanostructures and Nanomaterials; Bottom up and Bottom Down approaches; Surface Energy concept; Chemical potential of surface; different types of stabilizations.

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. Synthesis of Nano-materials.

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

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

#### **Recommended Books:**

1. Nanomaterials: The original product of nanotechnology by Maria Benelmekki. IOP Science (2019)

## Curriculum

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2. Nanostructures and Nanomaterials: Synthesis properties and applications by Cao, G., Wang, Y. 2nd ed. World Scientific, Singapore, (2011).
3. Nanoscale Science and Technology by Kelsall, Hamely & Geoghegan,. Wiley, (2005)

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

#### **Course Outlines:**

Tribology of surfaces: surface integrity; surface roughness and waviness; measurement of surface roughness and texture; friction and theories; types of wear and their mechanisms; lubrication and its regimes; applications of lubrications in wear

Mechanical surface treatment: Propelling abrasive media; blasting techniques; selection of abrasive media; different peening techniques. Surface finishing methods: selection and applications; tumbling; vibratory finishing; belt Sanding; wire brushing, buffing and electro-polishing. Chemical cleaning of surfaces: selection and applications; alkaline cleaning; solvent cleaning and vapor degreasing; molten salt bath cleaning; ultrasonic cleaning; acid cleaning; pickling and descaling.

Coatings: Paints and organic coatings; powder coating; hot-dip coating; chemical conversion coatings; blackening; coloring of metals; electroplating, electrophoretic deposition; anodizing; electroless-plating; mechanical plating; Chemical vapor deposition (CVD) and Physical vapor deposition (PVD) techniques; Thermal and cold spraying methods; Sputtering; sol gel method. A brief overview of surface hardening methods. Cladding techniques; roll bonding; explosive welding; applications of cladding in nuclear, marine and other technological fields

#### **Recommended Books:**

1. Surface Engineering: Enhancing Life of Tribological Components by Dheerendra Kumar Dwivedi, Springer (2018)
2. Tribology and Surface Engineering for Industrial Applications by Catalin I. Pruncu, Amit Aherwar, Stanislav Gorb, 1<sup>st</sup> Edition, CRC Press (2021)
3. Manufacturing Engineering & Technology by Serope Kalpakjian and Steve R. Schmid, 7th Edition, Pearson (2013)

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

#### **Course Outlines:**

Introduction to biomaterials and biochemistry; biocompatibility and bioactivity, bio-reabsorbable & bio-erodible materials. Hydrogels & smart polymers.

Cell biology, surface properties of materials, intermolecular forces in biology. Response of materials in human body; effect of mechanical forces on cells & tissues; biomimetic materials; Importance of water in biomaterials.

## Curriculum

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In-vivo and In-vitro testing. 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 William R. Wagner, Shelly E. Sakiyama-Elbert, ... Michael J. Yaszemski. Elsevier (2020)
2. Biomaterials: principles & applications by Joon B. Park, Joseph D. Bronzino. 1<sup>st</sup> ed. CRC Press (2002)
3. An Introduction to Biomaterials by Jeffrey O. Hollinger. 2<sup>nd</sup> ed. CRC Press, (2012)

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

#### **Course Outlines:**

Vacuum technology: Vacuum classification, Kinetic picture of a gas; Velocity Distribution, Mean free path, Collision frequency, Particle Flux, Monolayer Formation Time, Flow characteristics of gas (Knudsen number).

Vacuum pumps: Positive displacement pumps; Diaphragm pump, Water ring pump, rotary and roots pump, vapour ejector and vapour entrainment pumps, diffusion pump, turbo-molecular pump, ion pumps, sieve pumps, adsorption pumps.

Vacuum measuring devices: Manometers, McLeod gauge, Penning gauge, Pirani gauge, Ionization gauges.

Calculation of vacuum systems; conductance and throughput, 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 sintering, vacuum coatings.

### **Recommended books:**

1. Vacuum Technology by Alexander Roth. North-Holland, (2012)
2. Vacuum technology: practice for scientific instruments by Nagamitsu Yoshimura. Springer, (2008).
3. Vacuum Metallurgy by Choudhury, A. ASM Intl, (2000)

### **MME 408 Energy Materials 2(2,0)**

#### **Course Outlines:**



## Curriculum

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*Photovoltaic (PV) materials:* electromagnetic waves, light absorption, Solar radiation, solar spectra, solar energy concentration, solar cell parameters, losses and efficiency limits, crystalline silicon solar cells, thin-film solar cells, and other types, PV modules and systems, PV system economics and ecology.

*Battery materials:* Electrochemical fundamentals, electrochemical cell, charging and discharging, phase transition, order-disorder transition, electrode processes at equilibrium, energy efficiency, cycle life, Materials for electrode, Materials for non-rechargeable batteries, Materials for rechargeable batteries.

*Fuel cell applications:* Overview of fuel cell types, charge transfer and mass transport, Thermodynamics and reaction kinetics, Proton exchange membrane and solid oxide fuel cell materials, Fuel cell system design and characterization.

*Materials for hydrogen technology:* Methods of Hydrogen production, hydrogen from the decomposition of materials, Hydrogen storage in solids: metal hydrides, ammonia and related materials, reversible organic liquids.

*Lighting and Light Emitting Diodes:* Rare Earth Ions for LED Lighting Devices, Synthesis and luminescence study of phosphors, Synthesis and characterization of energy efficient organometallic complexes for OLED display applications

### **Recommended Books**

1. Energy Materials: Fundamentals to Applications by Sanjay Dhoble, N. Kalyani, B. Vengadaesvaran, Abdul Arof. Elsevier (2021)
2. Fuel Cell Fundamentals, O'Hayre, Cha, Colella, and Prinz. Wiley, (2016)
3. Energy Materials, D. W. Bruce, D. O'Hare, R. I. Walton. Wiley, (2011)

### **MME 409 Advanced Steels 2(2,0)**

#### **Course Outlines:**

Review of microstructure-property relationships in steels. Types of steels and their classification.

High strength low Alloy (HSLA), micro-alloyed, stainless steels, duplex, super duplex, high yield steels, IF (interstitial-free), Maraging Steels, TRIP steels, Ultra Low carbon steels, nitrogen containing fine grained steels, tool steels, die steels, Quenched and partitioned steels (QPS). Steels for low and high temperature applications, Orthopaedic steels, super alloys etc.

Production routes for advanced steels (VIM, VAR, ESR etc.), Processing of steels: thermo-mechanical processing, advantages and limitations, TMT steels, dual phase steels.

# Curriculum

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## **Recommended Books:**

1. Advanced Steels: From Materials Science to Structural Engineering by Wei Sha. Springer (2013)
2. Steels: Microstructure & Properties by Robert Honeycomb and Harry Bhadeshia. Elsevier (2005)
3. Physical Metallurgy and Design of Steels by Pickering, F. B. Applied Science Publishers (2000)

## **MME 410 High Temperature Materials 2(2,0)**

### **Course Outlines:**

Introduction to high temperature materials; applications; the phenomena and problems associated with high temperatures applications of materials.

High Temperature behaviour of Mechanical Materials: Plasticity, Fatigue and thermal fatigue, Creep.

High temperature chemical behaviour: Oxidation and Corrosion.

Design of alloys for high temperature. Refractory Metals, Inter-metallics, Stainless Steels, Nickel and Cobalt-based Superalloys, Ceramics and Cermets for High Temperature Applications. Alloy Theory, Heat Treatment and Hardening Mechanisms. Oxidation Resistant and Thermal Barrier Coatings.

### **Recommended Books:**

1. High Temperature materials and mechanisms by Yoseph Bar-cohen, Taylor & Francis Group (2014)
2. High Temperature Coatings by Bose. 2<sup>nd</sup> ed. Butterworth Heinemann (2017)
3. Materials for High Temperature Engineering Applications by Meetham, G.W., Van de Voorde, M.H. Springer (2000).

## **MME 413 Fracture and Failure Analysis 2(2,0)**

### **Course Outlines:**

Fracture and its types, ductile, brittle (intergranular and transgranular), Plane stress and plane strain conditions, Griffith's and Orowon theory of fracture.

Linear elastic and elastoplastic fracture mechanics. Fracture Toughness Testing, stress intensity factor and its range. Paris Law. Determination of  $K_{Ic}$ , Compact Tension, J-integral and Crack Opening Displacement (COD) methods. Tensile, Creep, Fatigue and environmental fractures. Stress corrosion cracking. Ductile to Brittle Transition Temperature and its determination. Fracture toughness testing of composites materials. Fracture toughness testing of reinforced/composite materials.

Failure analysis procedures; Fractography and Case studies of fractured components; different types of mechanical/industrial failures; root cause analysis and remedial actions

# Curriculum

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## **Recommended Books:**

1. Deformation and fracture mechanics of engineering materials by Hertzberg. 5th Edition. Wiley (2012)
2. ASM Handbook on Failure Analysis and Prevention, Volume 11, Latest edition
3. ASM Handbook on Fractography, Volume 12, Latest edition

## **MME 414 Functional Materials 2(2,0)**

### **Course Outlines:**

Introduction to functional materials; Crystal structure and functional properties relationship. Quantum Theory.

Electrical and thermal (vibration and phonons) conduction mechanism. Insulation, electrical, optical, photovoltaic and magnetic properties and applications of functional materials. Design and selection of materials

Surface properties; Surface and interfaces; growth of nano-structures; Photo-catalysis; antibacterial and biologically inert surfaces; Self-cleaning, easy-to-clean surfaces, bio ceramics. Functional materials coatings: anti-microbial coatings, air curable coatings, anti-ice coating; Functional coatings for metals, polymers and glasses: hydrophobic and hydrophilic surfaces; transparent conductive coating; barrier coatings; integrated functional coatings. Bio functional coatings: biocompatible and bioactive coatings. Material challenges and their implementation in devices, an introduction to the synthesis of some common functional materials

## **Recommended Books:**

1. Advanced Functional Materials by Tiwari, L. Uzun. Wiley (2015)
2. Biofunctional Surface Engineering by Martin Scholz. Pan Stanford Publishing (2014)
3. Handbook of Biofunctional Surfaces by Wolfgang Knoll. Pan Stanford (2013)

## **MME 415 Thin Film Technology 2(2,0)**

### **Course Outlines:**

Introduction to thin film technology. Thin film deposition and growth mechanism by Physical vapour deposition (PVD) techniques like evaporation, sputtering, ion-plating etc. Chemical coating methods such as chemical vapour deposition (CVD) and atomic layer deposition (ALD). Plasma based methods for thin film deposition. Molecular Beam Epitaxial (MBE) growth. Different physical and chemical processes. Substrate effects of coating deposition. Tribological and hard thin coatings. Functional coatings for devices. Models for nucleation and film growth. Morphology and texture. Applications of thin film materials and deposition technologies.

# Curriculum

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## **Recommended Books:**

1. Thin Film Coatings: Properties, Deposition, and Applications by Fredrick Madaraka Mwema, Tien-Chien Jen, Lin Zhu. Taylor and Francis (2022)
2. Handbook of Thin Film Technology by Hamid R. Khan. 1<sup>st</sup> Edition. Springer (2015)
3. Recent Advances in Thin Films by Editors: Sushil Kumar, D. K. Aswa. Springer (2020)

## **MME 416 Additive Manufacturing 2(2,0)**

### **Course Outlines:**

An overview of additive manufacturing: how it is different from conventional manufacturing processes; history. Process fundamentals; structure shaping and creation; applications of additive manufacturing. Role of CAD and laser scanning. Final component geometry. Different techniques used for 3D printing of metallic (SLM, EBM, LMD, powder DED, wire DED, binder jetting, BPE etc.) polymeric (FDM, SLS, stereolithography etc.) and other materials. Design implications; surface finish; microstructure' mechanical and other properties; residual stresses and effects on fatigue life.

### **Recommended Books:**

1. Additive Manufacturing by The Open University. The open learn (2019)
2. Introduction to Additive Manufacturing: technologies, materials, benefits, challenges and applications by Nicola Accialini. (2022)
3. Additive Manufacturing Technologies by by Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani. 3<sup>rd</sup> edition. Springer (2021)