CURRICULUM OF

Bachelor of Metallurgy and Materials Engineering

School of Chemical and Materials Engineering National University of Sciences and Technology, Islamabad

Framework
BE Metallurgy and Materials Program
Curriculum (134 CH)

- **Engineering 94 CH**
- **Non-Engineering 40 CH**
- **Conforms to PEC/HEC guidelines**

	HEC Guideline	Credit Hours (CH)	Percentage (%)
Engineering Courses	**68-72 %**	**94**	**70.15**
Non Engineering Courses	**28-32 %**	**40**	**29.85**

Non-Engineering Domain

Knowledge Area	Subject Area	Name of Course	CH
Natural Sciences [21 CH]	Math (12 CH)	MATH-101 Calculus and Analytical Geometry	3-0
		MATH-121 Linear Algebra and ODEs	3-0
		MATH-243 Vector Calculus	3-0
		MATH-351 Numerical Methods	3-0
	Physics (5 CH)	PHY-102 Applied Physics	2-1
		PHY-213 Physics of Materials	2-0
	Chemistry (4 CH)	CH-108 Applied Chemistry	3-1
Humanities [14 CH]	English (6 CH)	HU-100 English	2-0
		HU-212 Technical and Business Writing	2-0
		HU-109 Communication Skills	2-0
	Culture (4 CH)	HU-102 Islamic Studies	2-0
		HU-107 Pakistan Studies	2-0
	Social Sciences (4 CH)	HU-222 Professional Ethics	2-0
		ECO-130 Engineering Economics	2-0

Management Science [5 CH]	Management Sciences (8 CH)	OTM-454 Project Management	3-0
		MGT-271 Entrepreneurship	2-0
Non-Engineering Courses			**40**

Basic Engineering Courses

Engineering Foundation (EF) (22 CH)	• ME105 Workshop Practice (1CH) • ME109 Engineering Drawing (2CH) • EE-103 Electrical Engineering (3 CH) • MSE 101 Fundamentals of Engineering Materials (3CH) • MSE 231 X-ray Diffraction & Crystallography (3CH) • MSE-221 Materials Thermodynamics & Kinetics (3 CH) • MSE-201 Materials Engineering Lab-1 (1 CH) • MSE-202 Materials Engineering Lab-2 (1CH) • MSE-303 Materials Engineering Lab-3 (2 CH) • MSE-304 Materials Engineering Lab-4 (2 CH) • MSE-405 Materials Engineering Lab-5 (1 CH)
Computer System Engineering (6 CH)	• CS100 Fundamentals of ICT(3CH) • CS114 Fundamentals of Programming (3CH)

Major Based Core Breadth (MBCB)

Major Based Core Breadth [30 CH]	• MSE 241 Polymer Science (3CH) • MSE 213 Metals & Alloys-1 (3 CH) • MSE 317 Metals & Alloys-2 (3 CH) • MSE 342 Polymer Engineering (3 CH) • MSE 314 Manufacturing Processes (3 CH) • MSE 333 Materials Testing Techniques (3 CH) • MSE 351 Ceramics & Glasses (3 CH) • MSE 461 Composite Materials (3 CH) • MSE 483 Plant Design (3 CH) • MSE-325 Heat Treatment of Materials (3 CH)

Major Based Core Depth (MBCD)

Major Based Core Depth [28]	• MSE 224 Deformation & Fracture (3CH) • MSE 222 Phase Transformation & Equilibria (3CH) • MSE 313 Welding & Joining (2 CH) • MSE 316 Foundry Engineering (3 CH) • MSE 326 Corrosion & Protection (3 CH) • MSE 474 Surface Engineering of Materials (3 CH) • MSE 463 Nano-materials (2 CH) • Technical Elective-I (3 CH) • Technical Elective-II (3 CH) • Technical Elective-III (3 CH)

Interdisciplinary Engineering Breadth (IDEB)

Interdisciplinary Engineering Breadth [2]	• ME 312 Measurement and Instrumentation (2 CH)

Senior Design Project

Senior Design Project [6]	• MSE 499 Final Year Project -I (2 CH) • MSE 499 Final Year Project-II (4 CH)

Materials Engineering Elective Courses

Technical Electives (9 CH)	1. MSE381 Industrial safety (3CH) 2. MSE382 Design Standards & Quality assurance (3CH) 3. MSE383 Operations Research (3CH) 4. MSE481 Maintenance Management (3CH) 5. MSE482 Industrial Economics & Management (3CH) 6. MSE 485 Metallurgical Plants and Quality Control (3 CH) 7. MGT 401 Total Quality Management (3CH) 8. MSE371 Interfacial Phenomena (3CH) 9. MSE373 Tribological Phenomena on Surfaces (3CH) 10. MSE 385 Biomaterials and Applications 11. MSE 362 Introduction to Computational Materials Science (3 CH) 12. MSE473 Novel Techniques in Surface Engineering (3CH) 13. MSE452 Electronic and Magnetic Materials (3CH) 14. MSE 464 Advanced Materials (3 CH) 15. MSE 404 Design of experiments and data analysis (3 CH) 16. MSE 465 Powder Metallurgy (3CH) 17. MSE 471 Vacuum Technology in Surface Engineering (3 CH) 18. MSE 472 Surface Analysis and Characterization (3 CH)

Scheme of Study

Semester-Wise Breakdown [2020 intake and onwards]

Semester 1				
Sr. No.	Course Code	Subjects	CHs	Pre-requisite
1	EE-103	Electrical Engineering (Program specific)	2-1	None
2	HU-100	English	2-0	
3	MATH-101	Calculus and Analytical Geometry	3-0	
4	ME-105	Workshop Practice	0-1	
5	PHY-102	Applied Physics	2-1	
6	HU-107	Pakistan Studies	2-0	
7	CS-114	Fundamentals of Programming	2-1	
		Total CHs	**17**	
Semester 2				
Sr. No.	Course Code	Subjects	CHs	
8	MATH-121	Linear Algebra and ODEs	3-0	None
9	ME-109	Engineering Drawing	0-2	
10	HU-109	Communication skills	2-0	
11	CS-100	Fundamentals of ICT (Program specific)	2-1	
12	HU-101	Islamic Studies	2-0	
13	MSE-101	Fundamentals of Engineering Materials (Program specific)	3-0	
		Total CHs	**15**	
Semester 3				
Sr. No.	Course Code	Subjects	CHs	
14	CH-108	Applied Chemistry	3-1	
15	MATH-243	Vector Calculus	3-0	MATH-101
16	MSE-201	Materials Engineering Lab-1	0-1	
17	MSE-241	Polymer Science	3-0	
18	MSE-221	Materials Thermodynamics & Kinetics	3-0	
19	MSE-231	X-ray Diffraction & Crystallography	3-0	MSE-101
		Total CHs	**17**	
Semester 4				
Sr. No.	Course Code	Subjects	CHs	
20	ECO-130	Engineering Economics	2-0	
21	MATH-351	Numerical Methods	3-0	MATH-121

22	MSE-202	Materials Engineering Lab 2	0-1	
23	MSE-224	Deformation & Fracture	3-0	MSE-101
24	MSE-222	Phase Transformation & Equilibria	3-0	MSE-221
25	HU-212	Technical & Business Writing	2-0	
26	PHY-213	Physics of Materials	2-0	PHY-102
		Total CHs	**16**	
Semester 5				
Sr. No.	Course Code	Subjects	CHs	
27	MSE-303	Materials Engineering Lab 3	0-2	
28	MSE-313	Welding & Joining	2-0	MSE-101
29	MSE-316	Foundry Engineering	3-0	
30	MSE-333	Materials Testing Techniques	3-0	
31	MSE-342	Polymer Engineering	3-0	MSE-241
32	MSE-213	Metals and Alloys-1	3-0	MSE-101
33	MGT-271	Entrepreneurship	2-0	
		Total CHs	**18**	
Semester 6				
Sr. No.	Course Code	Subjects	CHs	
34	MSE-314	Manufacturing Processes	3-0	ME-105
35	MSE-304	Materials Engineering Lab 4	0-2	
36	MSE-326	Corrosion & Protection	3-0	MSE-213
37	MSE-317	Metals and Alloys-2	3-0	MSE-101
38	MSE-351	Ceramics & Glasses	3-0	MSE-101
39	MSE-XXX	Technical Elective - I	3-0	
		Total CHs	**17**	
Semester 7				
Sr. No.	Course Code	Subjects	CHs	
40	MSE-461	Composite Materials	3-0	MSE-101
41	OTM-454	Project Management	3-0	
42	MSE-405	Materials Engineering Lab 5	0-1	
43	MSE-474	Surface Engineering of Materials	3-0	
44	MSE-325	Heat Treatment of Materials	3-0	MSE-222
45	MSE-499	Final Year Project -I	0-2	
46	MSE/MGT-XXX	Technical Elective -II	3-0	
		Total CHs	**18**	
Semester 8				
Sr. No.	Course Code	Subjects	CHs	

47	MSE-483	Plant Design	3-0	
48	HU-222	Professional Ethics	2-0	
49	ME-312	Measurement & Instrumentation	2-0	
50	MSE-463	Nano-materials	2-0	PHY-213
51	MSE-499	Final Year Project-II	0-4	
52	MSE-XXX	Technical Elective-III	3-0	
		Total CHs	**16**	
		Grand Total	**134**	
Elective Courses				
Sr. No.	Course Code	Subjects	CHs	
1	MSE-371	Interfacial Phenomena	3-0	
2	MSE-373	Tribological Phenomena on Surfaces	3-0	
3	MSE-381	Industrial Safely	3-0	
4	MSE-382	Design Standards & Quality Assurance	3-0	
5	MSE-383	Operations Research	3-0	
6	MSE-471	Vacuum Technology in Surface Engineering	3-0	
7	MSE-472	Surface Analysis and Characterization	3-0	
8	MSE-473	Novel Techniques in Surface Engineering	3-0	
9	MSE-481	Maintenance Management	3-0	
10	MSE-482	Industrial Economics & Management	3-0	
11	MSE-404	Design of Experiments & Data Analysis	3-0	
12	MGT-401	Total Quality Management	3-0	
13	MSE-452	Electronic and Magnetic Materials	3-0	
14	MSE-362	Introduction to Computational Materials Science	3-0	
15	MSE-485	Metallurgical Plants and Quality Control	3-0	
16	MSE-464	Advanced Materials	3-0	
17	MSE-465	Powder Metallurgy	3-0	MSE-314
18	MSE-385	Biomaterials and Application	3-0	

Semester-Wise Breakdown [2018-19 intake ME-11& ME-12]

Semester 1				
Sr. No.	Course Code	Subjects	CHs	Pre-requisite
1	EE-103	Electrical Engineering (Program specific)	2-1	None
2	HU-100	English	2-0	
3	MATH-101	Calculus and Analytical Geometry	3-0	
4	ME-105	Workshop Practice	0-1	
5	PHY-102	Applied Physics	2-1	
6	HU-107	Pakistan Studies	2-0	
7	CS-114	Fundamentals of Programming	2-1	
		Total CHs	**17**	
Semester 2				
Sr. No.	Course Code	Subjects	CHs	
8	MATH-121	Linear Algebra and ODEs	3-0	None
9	ECO-130	Engineering Economics (Program specific)***	2-0	None
10	ME-109	Engineering Drawing	0-2	
11	HU-109	Communication skills	2-0	
12	CS-100	Fundamentals of ICT (Program specific)	2-1	
13	HU-101	Islamic Studies	2-0	
14	MSE-101	Fundamentals of Engineering Materials (Program specific)	3-0	
		Total CHs	**17**	
Semester 3				
Sr. No.	Course Code	Subjects	CHs	
15	CH-108	Applied Chemistry	3-1	
16	MATH-112	Calculus II	3-0	MATH-101
17	MSE-201	Materials Engineering Lab-1	0-1	
18	MSE-241	Polymer Science	3-0	
19	MSE-221	Materials Thermodynamics & Kinetics	3-0	
20	MSE-231	X-ray Diffraction & Crystallography	3-0	MSE-101
		Total CHs	**17**	
Semester 4				
Sr. No.	Course Code	Subjects	CHs	
21	MATH-351	Numerical Methods	3-0	MATH-121
22	MSE-202	Materials Engineering Lab 2	0-1	

23	MSE-224	Deformation & Fracture	3-0	MSE-101
24	MSE-222	Phase Transformation & Equilibria	3-0	MSE-221
25	HU-212	Technical & Business Writing	2-0	
26	PHY-213	Physics of Materials	2-0	PHY-102
		Total CHs	**14**	
Semester 5				
Sr. No.	Course Code	Subjects	CHs	
27	MSE-303	Materials Engineering Lab 3	0-2	
28	MSE-313	Welding & Joining	2-0	MSE-101
29	MSE-316	Foundry Engineering	3-0	
30	MSE-333	Materials Testing Techniques	3-0	
31	MSE-342	Polymer Engineering	3-0	MSE-241
32	MSE-213	Metals and Alloys-1	3-0	MSE-101
33	MGT-271	Entrepreneurship	2-0	
		Total CHs	**18**	
Semester 6				
Sr. No.	Course Code	Subjects	CHs	
34	MSE-314	Manufacturing Processes	3-0	ME-105
35	MSE-304	Materials Engineering Lab 4	0-2	
36	MSE-326	Corrosion & Protection	3-0	MSE-213
37	MSE-317	Metals and Alloys-2	3-0	MSE-101
38	MSE-351	Ceramics & Glasses	3-0	MSE-101
39	MSE-3XX	Technical Elective - I	3-0	
		Total CHs	**17**	
Semester 7				
Sr. No.	Course Code	Subjects	CHs	
40	MSE-461	Composite Materials	3-0	MSE-101
41	OTM-454	Project Management	3-0	
42	MSE-405	Materials Engineering Lab 5	0-1	
43	MSE-474	Surface Engineering of Materials	3-0	
44	MSE-325	Heat Treatment of Materials	3-0	MSE-222
45	MSE-499	Final Year Project -I	0-2	
46	MSE/MGT-XXX	Technical Elective -II	3-0	
		Total CHs	**18**	
Semester 8				
Sr. No.	Course Code	Subjects	CHs	
47	MSE-483	Plant Design	3-0	
48	HU-222	Professional Ethics	2-0	

49	ME-312	Measurement & Instrumentation	2-0	
50	MSE-463	Nano-materials	2-0	PHY-213
51	MSE-499	Final Year Project-II	0-4	
52	MSE-4XX	Technical Elective-III	3-0	
		Total CHs	**16**	
		Grand Total	**134**	
Elective Courses				
Sr. No.	Course Code	Subjects	CHs	
1	MSE-371	Interfacial Phenomena	3-0	
2	MSE-373	Tribological Phenomena on Surfaces	3-0	
3	MSE-381	Industrial Safely	3-0	
4	MSE-382	Design Standards & Quality Assurance	3-0	
5	MSE-383	Operations Research	3-0	
6	MSE-471	Vacuum Technology in Surface Engineering	3-0	
7	MSE-472	Surface Analysis and Characterization	3-0	
8	MSE-473	Novel Techniques in Surface Engineering	3-0	
9	MSE-481	Maintenance Management	3-0	
10	MSE-482	Industrial Economics & Management	3-0	
11	MSE-404	Design of Experiments & Data Analysis	3-0	
12	MGT-401	Total Quality Management	3-0	
13	MSE-452	Electronic and Magnetic Materials	3-0	
14	MSE-362	Introduction to Computational Materials Science	3-0	
15	MSE-485	Metallurgical Plants and Quality Control	3-0	
16	MSE-464	Advanced Materials	3-0	
17	MSE-465	Powder Metallurgy	3-0	MSE-314
18	MSE-385	Biomaterials and Application	3-0	

Courses- BE Metallurgy and Materials

HU-100 English

Credit Hours: 2-0

Pre-requisites: None

Course Objectives

- To enhance language skills and develop critical thinking

Course Contents

- Basics of Grammar
- Parts of speech and use of articles
- Sentence structure, Active and passive voice
- Practice in unified sentence
- Analysis of phrase, clause and sentence structure
- Transitive and intransitive verbs
- Punctuation and spelling

Course Outcome

- Understands basics of Grammar
- Improves listening, writing and speaking skills
- Develops translational and presentation skills

Suggested Books

- Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
- Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
- Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

PHY-102 Applied Physics

Credit Hours: 2-1

Pre-requisites: None

Course Objectives

- Physics aims to explain how things work from the smallest to the largest of scales.
- It takes in practice and theory, specialist pure research and applications in the surroundings of everyday life.
- The main objective of the course is to teach students how to effectively read scientific material, identify fundamental concepts, reason through scientific questions, and solve quantitative problems.

Course Contents

- Core concepts in Newtonian Mechanics: space, time, mass, force, momentum, torque, and angular momentum; the principles of mechanics.
- Conservation Laws involving energy, momentum and angular momentum.
- Heat transfer and thermometry, principles of Optics, linear propagation of light, magnification and optical lenses.
- Magnetism, Electricity, Electromagnetic effect, laws of electromagnetic induction, principal of transformer, galvanometer, ammeter, voltmeter, condensers and dielectric properties.

Course Outcome

- Graduates will have the understanding in the basic principles of physics and thinking skills necessary to construct an appropriate understanding of physical phenomena in an applied context.

Suggested Books

- Young, Hugh D., and Roger A. Freedman. University Physics.11th ed. with Mastering Physics. Reading, MA: Addison-Wesley, 2004.
- John D. Cutnell, Kenneth W. Johnson, Physics, Wiley 7th Edition

EE-103 Electrical Engineering

Credit Hours: 2-1

Pre-requisites: None

Course Objectives

- To impart the basic knowledge of electrical machines and electronics.

Course Contents

- Introduction to DC Circuits: Series and Parallel circuits, DC Circuit analysis, Theory of Alternating Current, Series and Parallel circuits, Resistance, inductance and capacitance of AC circuits, Power factor, Resonance in RLC circuits, Single and poly-phase circuits, Power and power factor measurement, Current and voltage relationship in phase and line circuits

Course Outcomes

- The students will get basic knowledge of electrical engineering to understand alternating current, direct current and associated circuits. They will also understand back ground information for electrical instruments and electrical machinery being used in chemical industry.

Suggested Books

- T.L. Floyd, D.M. Buchla, Electronic Fundamentals: Circuits, devices and applications, 8th Edition, Prentice Hall, (2009)
- J. Bird, Electrical circuit theory and technology, 2nd Edition, Newnes Publication, (2003)

CH-108 Applied Chemistry

Credit Hours: 3-1

Pre-requisites: None

Course Objective

- This course gives the students a sound and fundamental knowledge of organic, inorganic and analytical chemistry.

Course Contents

- Structure and bonding, Acids and bases, Introduction to organic molecules and functional groups, Alkanes, Alkenes, Alkynes, Stereochemistry, ethers and epoxides, Benzene and aromatic compounds, Understanding organic reactions; reactions of aliphatic hydrocarbons, Aromatic hydrocarbons, Coordination chemistry; structural isomerism, stereo isomerism, coordination number and structure, Macromolecular reactions for LDPE, HDPE, PP;

- Chemistry of solutions (acid base theories, pH, buffer solutions), Electrochemistry: Electron transfer reaction (Redox process), Oxidation reduction reactions, oxidizing and reducing agents, Extraction of metal from ore (iron ore, alumina etc) e.g, Aluminum from alumina, Refinning of metals e.g. iron, copper etc
- Introduction to analytical chemistry and instrumental techniques / qualitative and quantitative analysis, Separation methods, Spectroscopic methods (Introduction of IR, Mass and NMR), Chromatography (Plane chromatography, Liquid-solid chromatography, Paper chromatography, Thin-layer and column chromatography), Potentiometery, pH metery, UV and visible spectroscopy,

Course Outcome

- After the course students will be able to use chemistry as a strong tool to understand and develop the practical problems which they come across in engineering/technology.

Suggested Books

- O.V. Roussak, H. D. Gesser, Applied Chemistry, 2nd Edition, Springer US, (2013)

- Edward A. Parnell, Applied Chemistry, D. Appletion& Co. (2007)
- M. Farhat, Industrial Chemistry, 1st Edition, McGraw Hill,(2004)

PHY-213 Physics of Materials

Credit Hours: 2-0

Pre-requisites: PHY-101 (Applied Physics)

Course Objectives

- Solid state includes most of the materials in that make modern technology possible
- Properties of the solid state differ significantly from the properties of isolated atoms or molecules
- The term 'structure' takes on a whole new meaning. Example: Nano sized metal particles etc.

Course contents

- Electrical Properties: Electrical conductivity, Energy band structures in solids, Conduction in terms of band and Atomic Bonding Models, Carrier mobilities, Intrinsic and Extrinsic Semiconductors. Thermal Properties: Lattice dynamics, Phonons, Magnetic properties: type of magnetisms. Domains and Hysteresis, Soft and Hard Magnetic Materials, Optical Properties: Electromagnetic radiation, Light interaction with solids, Luminescence, Photoconductivity

Course Outcome

- At the end of the course the students are expected to have learned the following:
  a. How to differentiate between the bonding forces
  b. To understand physical concepts of specific heat models
  c. To predict electrical and magnetic properties of materials.
  d. Deep understanding the semiconducting properties of the materials
  e. Optical properties of materials.

Suggested Books

- William D. Calister, Jr. David G. Rethwisch, Material Science and Engineering; An Introduction, 8th Edition, Wiley, (2010)
- John Philip McKelvey, Solid State Physics for Engineering and Materials Science, Reprint Edition, Krieger Publishing Company, (1993)

- Daniel D. Pollock, Physical Properties of Materials for Engineers, 2nd Edition, CRC press, (1993)
- Kittel, Charles. Introduction to Solid State Physics.7th Edition,. New York Wiley,(1996)
- Neil W. Ashcroft, N. David Mermin, Solid State Physics, Reprint Edition,Holt, Rinehart and Winston, (1976)

MSE-213 Metals and Alloys-1

Credit Hours: 3-0

Pre-requisites: MSE-101 (Fundamentals of Engineering Materials)

Course Objectives

- The course is designed to study the unique properties and structure of metals and alloys. The basic goals are:
  a. To introduce the rudimentary concepts about ferrous metals and alloys.
  b. To introduce the manufacturing and processing methods of steels.

Course Contents

- Iron-making processing, direct and indirect reduction, blast furnace process and its design, charge and energy calculations in blast furnace, blast furnace products and their treatments, developments in blast furnace process. Production of cast iron, Description and properties of the types of cast iron (Gray, White, Malleable and Ductile cast irons), Iron-Carbon (Fe-C) and Iron- Cementite (Fe-Fe3C) Systems.

- Raw materials for steel-making and its processes, pneumatic steel-making processes. Description and properties of carbon steels & Stainless Steels. Prospects of iron and steel making in Pakistan. Designation system of iron and steels (ASTM, AISI, DIN etc).

Course Outcome

- The student should be able to,

  a. Understand primary extraction processes involved in iron making from its raw materials.
  b. Understand the principles and practice of pneumatic, open-hearth, electric, duplex and triplex steel making processes.

Suggested Books

- Donald R. Askeland, The Science and Engineering of Materials, 7thEditon, Global Engineering, (2015)
- R.H. Tupkary and V.R. Tupkary, An introduction to modern steel making, 6th Edition, Khanna Publisher, (1998)

MSE-317 Metals and Alloys-2

Credit Hours: 3-0

Pre-requisites: MSE-101 (Fundamentals of Engineering Materials)

Course Objectives

- The course is designed to study the unique properties and structure of metals and alloys.The basic goals are:
  a. To introduce the rudimentary concepts about metals and alloys.
  b. To introduce the manufacturing and processing methods of steels and nonferrous alloys.

Course Contents

- Non-ferrous metals and their ores, extraction and refining of non-ferrous metals, Aluminium, Copper, Zinc, Magnesium, Titanium, Nickel, Chromium, Silver, Gold, Tungsten and molybdenum, common non-ferrous alloys and their melting procedures, Designation systems of Al, Cu, Zn, Mg, Ti, Ni, Cr etc.

Course Outcome

- The student should be able to understand;
  a. Extraction and refining processes of common ferrous and non-ferrous metals and alloys.
  b. Designation systems and common properties of various ferrous and non-ferrous alloys.

Suggested Books

- Donald R. Askeland, The Science and Engineering of Materials, 7thEditon,GlobalEngineering,(2015)
- Francoise Cardarelli, Materials Handbook, 2nd Edition, Springer, (2008)

MSE-314 Manufacturing Processes

Credit Hours: 3-0

Pre-requisites: ME-105 (Workshop Practice)

Course Objectives

- The course is designed to introduce the basic concepts of manufacturing processes for engineering applications, to undergraduate students of materials engineering. The specific course objectives are:
  - To learn about metal casting processes and equipment
  - To study the forming and shaping processes e.g. rolling, forging, extrusion and drawing, sheet-metal forming etc.
  - To introduce powder metallurgy and its use in manufacturing
  - To understand material removal processes and machines

Course Contents

General introduction to manufacturing, Design process and Concurrent Engineering., Forming and shaping processes and equipment, Rolling of metals, Forging, Extrusion and drawing of metals, Sheet metal forming. Metal injection molding, ceramic injection molding.

a. Powder metallurgy

Fundamental theory and principles, Production of metallic powders, compaction of metal powder, cold compaction, hot compaction, Powder characterization techniques, Lubricants and binders, Shaping processes, Sintering, Characterization of sintered components, manufacturing of sintered carbides.

b. Machining processes

Fundamentals of Cutting, Material removal processes and machines, Machining, Advanced machining processes, Computer integrated manufacturing technology.

Course Outcome

a. The student should be able to understand the process of rolling, forging, extrusion and drawing on metallic alloy components and their effect on microstructure and mechanical properties.
b. The student should be able to understand fundamental theory and principles of powder metallurgical processing including compaction, calcination and sintering.
c. The student should be able to understand fundamental and advanced machining processes.

Suggested Books:

- Randall M. German, Powder Metallurgy, 2nd Edition, Metal Powder Industries Federation, (1994)
- SeropeKalpakjian, Steven R. Schmid, Manufacturing Engineering and Technology, 6th Edition, Prentice Hall, (2010)

- Mikell P. Groover, Fundamentals of Modern Manufacturing, 4th Edition, Wiley,(2010)

CS-100 Fundamentals of ICT

Credit Hours: 2-1

Pre-requisites: None

Course Objectives

- This course aims to deliver basic knowledge about the computer software and hardware tools to student's and complete knowledge of the basic computer accessories and their applications.

Course Contents

- Topics on the engineering of computer software and hardware systems
- Techniques for controlling complexity
- Strong modularity using client-server design, virtual memory, and threads; networks; atomicity and coordination of parallel activities
- Recovery and reliability; privacy, security, and encryption; and impact of computer systems on society
- Case studies of working systems and readings from the current literature for comparisons and contrasts; design projects

Course Outcome

Students after studying this course should have concepts of :

- General application software
- Basic computing hardware
- Operating systems, desktop publishing
- Internet using
- Computer accessories
- Computer components and their respective functions.

Suggested Books

- J. Stanley Warford, Computer Systems 2009 4th Edition, Jones and Bartlett Publishers
- Douglas E Comer, Essentials of Computer Architecture 3rd Edition, Jones and Bartlett Publishers

CS-114 Fundamentals of Programming

Credit Hours: 2-1

Pre-requisites: None

Course Objectives

- The main objective of this course is to introduce students to basic computer concepts and programming. At the end of this course students will be able to write useful and efficient software programs to solve basic computing problems.

Course Contents

- Introduction to Programming: Phases of compilation and execution, Types of files and types of translators.
- Variables, Data Types and Operators: Concept of variables, input and output statements, precedence and associatively of arithmetic operators, assignment operators.
- Selection constructs: Relational operator sand logical operators, bool data type, single selection--if, double selection if-else, multiple selection else-if, conditional expressions and switch statement.
- Loops: Known repetitions ---for, Unknown repetitions --- do-while and while, concept of sentinel value, nested constructs, break and continue statements.
- Functions: Declaration, defining functions, comparison with library functions, passing arguments, constants, variables, returning values from function. Passing arguments by value and reference mechanism. Overloaded functions, inline functions, default arguments. Variables and storage classes, auto, external and static variables.
- Arrays: Definition, accessing elements, initialization, one dimensional arrays, multidimensional arrays, passing arrays to function, reinforcement of arrays in conjunction with loops.

Course Outcome

At conclusion of this course students should have the knowledge of:

- Basic computer programming overview
- Basic software language overview
- Basics of structured and modulated programming
- Analyzing problem and designing solution.
- Basic Algorithms and problem solving using software.

Suggested Books

- C++ How to program by Deitel and Deitel, Prentice hall, Latest Edition, ISBN: 0- 13-185757-6
- The Waite Group's Turbo C Programming for the PC by Robert Lafore
- Java How To Program (late objects) by Paul Deitel, Harvey Deitel
- Learning Python, 5th Edition by David Ascher and Mark Lutz

HU-109 Communication Skills

Credit Hours: 2-0

Pre-requisites: None

Course Objectives

- Basics of English language
- Mode of communication
- Management skills
- Conflict management

Course Contents

- Basics of English Language, the written word, Telephone skills
- E-Communication, Body Language, Job Application & CVs, Job Interviews
- Meetings, Handling Conflict, Public Speaking, Audio-visual aids
- Working in global Teams, Communicating Science & Technology
- Talking to the Media, Online Communication & Management Skills
- Speaking Skills:
    a. Phonetics in effective Communication
    b. Phonetic Transcription
    c. Pronunciation
    d. Varieties of English
    e. Stress and Intonation
    f. Barriers in Effective Verbal Expression
    g. Art of Discussion and Debate
    h. Public Speaking.
    j. Vocabulary Building.
- Reading Skills:
    i. Structure of English Language
    j. Grammar and Syntax
    k. Skimming of gist of a Text
    l. Scanning for specific information
    m. Fast Reading
    n. Understanding of punctuation
    o. Understanding context
    p. Understanding the relationship between sentences and clauses in a text
    q. Recognizing the effects of style

r. Making inferences

- Presentation and listening skills:

Principles of Technical Communication

s. Multimedia and Paper Presentations

t. Presentation Practice by the students.

Course Outcome

- Have improved communication skills
- Ability to prepare CVs and skills for interviews
- Ability to work in teams
- Ability to effectively utilize different means of communications
- Ability to hold meetings and other gatherings and address them
- Ability to resolve conflicts
- Ability to address real life problems

Suggested Books

- Jon Venables Communication Skills for Engineers and Scientists 4th Edition2007
- Read Better, Writye better – Reader's Digest Compilation.
- Gliden H.K, Reports, Technical Writing, and Specifications; London, McGraw-Hill Book Company.
- Steve M.Gerson/Sharon J. Gerson Technical Writing; Addison Wesley Longman (Singapore) Pte.Ltd.
- Better Vocabulary by Edie Schwager

MATH-101 Calculus and Analytical Geometry

Credit Hours: 3-0 CHs

Course Objectives

Course Contents:

- Review of vectors, scalars and vector products. Three dimensional coordinate system and equation of straight line and plane Limits & continuity, techniques of finding limits
- Techniques of differentiation, Tangent lines and rates of change, Extrema of functions, Rolle's and Mean value theorems, Concavity, Riemann sum, definite integrals and properties of integrals
- Solids of revolution, volume of solids of revolution by Cylindrical shell & Cross section methods, Arc length, surface of revolution, Center of mass Indeterminate forms and L Hospital rule, trigonometric integrals.
- Improper Integrals, Convergence and divergence of sequences and series, positive term, series, integral test
- Basic comparison test, limit comparison test, the ratio and root tests, alternating series, absolute and conditional convergence
- Power series, Maclaurin and Taylor series

Course Outcome

Text Book: Swokowski, Onlinick & Pence: Calculus (6th Edition)
Reference Book: Robert T. Smith & Roland B. Minton: Calculus (3rd Edition)

MATH-112 Calculus II

Credit Hours: 3-0

Pre-requisites: MATH -101

Course Objectives

- The course gives the students a sound knowledge of calculus giving them a reasonable background of three-dimensional geometry, which is necessary to understand calculus.
- The course gives the systems a sound knowledge of calculus giving them a reasonable background of Three-dimensional Geometry which is necessary to understand calculus.
- After pre-calculus review, the course introduces function of several variables, their limits and continuity and partial differentiation.
- Double and triple integration are included with applications to find areas and volumes.
- First order and higher order differential equations are included so that the students feel comfortable in making mathematical models of physical systems. Fourier series are included to make them capable of tackling period signals.

Course Contents

- Limits, Continuity and Discontinuity
- Introduction to Ordinary Differential Equations, 1st and 2nd order Differential Equations
- Transcendental functions, techniques and applications of integration, indeterminate forms, improper integrals, polar coordinates, infinite series and applications
- Taylor polynomials, Fourier series and transforms

Course Outcome

After a course student will be able to use mathematics as a strong tool to understand and develop the practical problems which they come across in Engineering/Technology.

Suggested Books

- Stewart, Calculus: Concepts and Contexts 7th Edition 2012
- D. G. Zill, Introduction to Differential Equations, Brooks Cole Publishing, 2000
- Edwards, C., and D. Penney Elementary Differential Equations with Boundary Value Problems. 6th Edition Upper Saddle River, NJ: Prentice Hall, 2003.

MATH-243 Vector Calculus

Credit Hours: 3-0

Pre-requisites: MATH -101

Course Objectives

- To develop understanding Vector Calculus and Partial Differential Equations.

Course Contents

- Analytical Geometry in 3-space
- Quadratic Surfaces, Cylindrical and Spherical coordinates
- Parametric representation of curves, Arc length Curvature &Torsion
- Gradient of a Scalar Field and directional derivatives
- Divergence of a Vector Field.
- Curl of a Vector Field.
- Line integral, integration around closed curves.
- Application of double integrals, Green's theorem. Surface Integrals. Triple integrals, Divergence theorem of Gauss. Stoker's theorem.
- Partial differential equations solvable as ODEs (separation of variables) Modeling a Vibrating String, Derivation of Wave Equation
- Solution by the Method of Separation of Variables using Fourier series.

Text Book: a. E. Kreyszing, Advanced Engineering mathematics (9^{th} edition)

b. Swokowski, Onlinick & Pence: Calculus (6^{th} Edition)

Reference Book: Borisenko & Taranov, Vector and Tensor Analysis with Applications.

ME-105 Workshop Practice

Credit Hours: 0-1

Pre-requisites: None

Course Objectives

- To impart knowledge of workshop techniques.

Course Contents

- Bench fitting: Description, proper use and maintenance of the fitting tools: use and care of measuring instruments
- Preparation of some specific jobs
- Forging: Hand forging, Use and maintenance of forging tools, the fore anvils, hammers, chisels, fullers, swages, punches, drifts, tongs, Prepare some specific jobs using forging methods
- Use of power hammer, drop and press forging, riveting. Wood working
- Use & care of wood working tools, clamps, saws, planes, files, rasps, chisels, drills, bits, planning, nailing, screwing, jointing, doweling
- Use and care of natural wood, chipboard, plywood, hardboard etc.
- Safety and care
- Precautions necessary in many shops machine accidents, general cleanliness of shop, proper appraisal, accident alarms and evacuation.

Course Outcome

Student will be able to perform following operations:

- Bench fitting: Description, proper use and maintenance of the fitting tools: use and care of measuring instruments, Preparation of some specific jobs.
- Forging: Hand forging, Use and maintenance of forging tools, the fore anvils, hammers, chisels, fullers, swages, punches, drifts, tongs, Prepare some specific jobs using forging methods. Use of power hammer, drop and press forging, riveting.
- Wood working: Use & care of wood working tools, clamps, saws, planes, files, rasps, chisels, drills, bits, planning, nailing, screwing, jointing, doweling. Use and care of natural wood, chipboard, plywood, hardboard etc.
- Safety and care: Precautions necessary in many shops machine accidents, general

cleanliness of shop, proper appraisal, accident alarms and evacuation.

Suggested Books

- Alfred Parr Longmans, “Workshop Practice”, Green, and Company 2007
- Henry Wright Baker, “Modern Workshop Technology”, Cleaver-Hume Press, 2006
- Alfred Parr Longmans, “Machine Tools and Workshop Practice” Green & Company 2007
- Raymond Francis Yates “Model Making Including Workshop Practice” The Norman W. Henley publishing company, 2007
- Garg, S.K., Comprehensive Workshop Technology 2009 Laxmi Publications, ISBN 8170086353

ME-109 Engineering Drawing

Credit Hours: 2-0

Pre-requisites: None

Course Contents

- Line types projection theory
- Drawing Instruments & geometric construction
- Orthographic projections
- Dimensioning
- Isometric Drawings
- Orthographic views of building drawings or
- Constructing Isometric drawings from projection & Auto CAD.
- Sectional views of building drawings or
- Assembly drawing & identifying missing features & views.

Suggested Books

- N.D Bhatt, *Engineering Drawing and Graphics*
- B. Wiebe, M. Mohler ,*Technical Graphics Communication,* McGraw-Hill
- Abbot, *Practical Geometry & Engineering Graphics*
- Craft, Meyers & Boyer, *Engineering Graphics*
- G. R. Bertoline, E. N. Wiebe, *Technical Graphics Communication*; McGraw-Hill
- D.F. Rogers, J.A. Adams; *Mathematical Elements for Computer Graphics*, McGraw-Hill A. C Parkinson, A First Year Engineering Drawing

MSE-101 Fundamentals of Engineering Materials

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- The course is designed to introduce the basic concepts of materials science and engineering. The specific course objectives are:
- To introduce the materials sciences and engineering concepts, classification of materials
- To teach the types of bonding in materials/solids
- To study the crystal structures and properties associated with them
- To introduce strengthening mechanisms and imperfections in solids.
- To introduce the mechanical properties of materials and their measurements.
- To study the processing of ceramics, composites, and polymeric materials.

Course Contents

Introduction to materials science and engineering, Classifications of materials, Atomic Structure, Atomic bonding in solids, Crystal structures, Crystalline and non-crystalline materials, crystallographic points, directions and planes, Imperfections in crystalline solids, Microscopic examinations. Fundamentals of corrosion, Mechanical properties of solids, Elastic behavior of metals, Plastic behavior of metals, Compressive, shear and torsion, hardness, Property variability and design safety factor, Phase diagram, Binary Phase diagrams, Iron-Carbon system, Ceramic structures, Processing of ceramics, Polymeric materials and their processing, composite materials and their processing

Course Outcome

At end of the course the students are expected to have learned the following:

- How to calculate the crystal density / atomic packing factor.
- To develop the understanding of crystallization plans and directions.
- To predict properties based on the microstructure plans and directions.
- Find out mechanisms of strengthening in a material.
- Understanding of materials processing and their structure-property relationship.

Suggested Books

- Callister, W.D. and D.G. Rethwisch, Fundamentals of Materials Science and Engineering: An Integrated Approach2012: Wiley.
- Allen, S. M., and E. L. Thomas, *The Structure of Materials*. New York, NY: J. Wiley & Sons, 1999

HU-107 Pakistan Studies

Credit Hours: 2-0

Pre-requisites: None

Course Objectives

- The course has been designed as a compulsory subject for the students studying for Bachelor's degree, general or professional.
- The course is of 3 credit hours carrying 100 marks (recommended). The teaching work is comprised of three dimensions: Historical Perspective (20%); Government and Politics (40%); and Contemporary Pakistan (40%).
- The course framework is issue-oriented. It has many dimensions, the historical and ideological background of Pakistan the process of governance and national development as well as the issues arising in the modern, age and posing challenges to Pakistan. The course has been designed with a vision that Pakistan Studies should open a window to future.

Course Contents

- **Historical Perspective**
  - Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.
  - Factors leading to Muslim separatism
  - People and Land
  - Indus Civilization
  - Muslim advent
  - Location and Geo-Physical features.
- **Government and Politics in Pakistan**

  Political and constitutional phases:
  - 1947-58
  - 1958-71
  - 1971-77
  - 1977-88
  - 1988-99
  - 1999 onward

- **Contemporary Pakistan**
    - Economic institutions and issues
    - Society and social structure
    - Ethnicity
    - Foreign policy of Pakistan and challenges
    - Futuristic outlook of Pakistan

Course Outcome

- Historic Prospective
- Ideology of Pakistan
- Government and Politics in Pakistan
- Contemporary Pakistan; a. Economic institutions and issues b. Society and social structure c. Ethnicity d. Foreign policy of Pakistan and challenges e. Futuristic outlook of Pakistan

Suggested Books

- Burki, Shahid Javed. State & Society in Pakistan, The Macmillan Press Ltd 1980.
- Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi, Oxford University Press, 2000.
- S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
- Mehmood, Dr. Safdar. Pakistan Political Roots & Development. Lahore, 1994.
- Wilcox, Wayne. The Emergence of Bangladesh. Washington: American Enterprise, Institute of Public Policy Research, 1972.
- Mehmood, Safdar. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
- Tahir Amin. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
- Ziring, Lawrence. Enigma of Political Development. Kent England. Wc Dawson & sons Ltd, 1980.

MATH-121 Linear Algebra and ODEs

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- To teach techniques for solving ordinary differential equations and impart different concepts of linear algebra.
- Develop fundamental skills of solving ordinary differential equations, and developing differential equations for real-world problems
- Differential Equations are the language in which laws of nature are expressed. Understanding properties of solutions of differential equations is fundamental to much of contemporary science and engineering.
- Ordinary differential equations (ODE's) deal with function of one variable, which can often be thought of as time. Partial differential equations have classical problems of heat and wave equations.

Course Contents

- **Linear Algebra**

Basic Concepts. Matrix Addition. Scalar Multiplication Matrix Multiplication, Linear Systems of Equations. Gauss Elimination. Solution of Linear Systems: Existence, Uniqueness, General Form Inverse of a Matrix. Gauss-Jordan Elimination. Vector Spaces, Sub Spaces and Linear Transformations, Linear dependence, linear independence, spanning set, basis, Eigenvalues and Eigenvectors

- **First Order Ordinary Differential Equations**

Separable Variables. Homogeneous Equations. Exact Equations and Integrating Factors. Linear Equations. Equations of Bernoulli, Ricatti and Clairaut. Applications of Linear and Non-Linear First Order ODEs.

- **Linear Differential Equations of Higher Order**

Preliminary Theory. Initial and Boundary Value Problems. Linear Dependence and Linear Independence. Homogeneous Linear Equations with constant coefficients.

- **Non-Homogeneous Linear Equations with constant coefficients**

Undetermined Coefficients. Variation of Parameters.

- **Non-Homogeneous Linear Equations with Variable Coefficients**

Cauchy-Euler Equation.

- **Laplace Transform**

Laplace Transform and Inverse Transform. Unit step function, Dirac delta function
Solution of 1st and higher order initial value problem using Laplace Transform.

Course Outcome

- After this course student will be able to use mathematics as a strong tool to understand and develop the practical problems which they come across in Engineering Technology.

Suggested Books

- Edwards, C., and D. Penney. *Elementary Differential Equations with Boundary Value Problems*. 6th Edition. Upper Saddle River, NJ: Prentice Hall, 2003.
- Erwin Kreyszig, Advanced Engineering Mathematics 10^{th} Edition, John Wiley, 2010

MSE-201 Materials Engineering Lab I

Credit Hours: 0-1

Pre-requisites: None

Course Objectives

- To introduce about the basic of labs lay out, identification of materials, XRD, specimen metallography, Hardness tests and Heat Treatment,

Course Contents

- Introduction & layout of all labs, Identification of Engineering materials
- Introduction to XRD, Braggs Law, Method of Identification of XRD Unknown pattern
- Determination of (h,k,l) values, d-spacing, lattice parameter (a), crystal structure, theoretical density and porosity of given material from XRD data for F.C.C materials
- Measurement of packing factor make use of theory of errors
- Specimen preparation for metallography , Metallographic (Quantitative Analysis)
- Brinell Hardness Test , Heat Treatment of steel samples in Muffle furnace
- To find coefficient of performance(COP) of Mechanical heat pump, To study the effect of water flow rates on condenser and evaporation of refrigeration cycle demonstration Unit
- Line tracing of Mechanical Heat Pump , Line tracing of Thermal Expansion Unit

Course Outcome

- After attending this course students will be aware of general layout of various labs, X- Ray Diffraction, and Specimen preparation for Metallography, Hardness and Heat Treat.

Suggested Books

- Consult the books related to the subjects covered in semester 3

MSE-221 Materials Thermodynamics & Kinetics

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- To introduce fundamental concepts in thermodynamics of material systems
- To describe laws of thermodynamics that govern any changes in the state of a system
- To develop an understanding of how different certain variables lead a system to an equilibrium state
- To differentiate between macroscopic and microscopic equilibrium states
- To discuss different types of equilibria including those involving chemical reactions
- Laws of Thermodynamics
- Chemical and electrochemical equilibriums
- Thermodynamic treatment of materials
- Kinetics aspects like diffusion, phase transformation and microstructure development

Course Contents

- Treatment of the laws of thermodynamics and their applications to equilibrium and the properties of materials
- General phenomena in materials science and engineering, including chemical reactions, magnetism, polarizability, and elasticity
- Relations pertaining to multiphase equilibria as determined by a treatment of solution thermodynamics
- Graphical constructions essential for the interpretation of phase diagrams
- Treatment includes electrochemical equilibria and surface thermodynamics
- Aspects of statistical thermodynamics related to macroscopic equilibrium phenomena
- The kinetics aspect includes diffusion, phase transformations, and the development of microstructure

Course Outcome

By the end of this course, the student is expected to:

- An ability to apply and couple the basic concepts of thermodynamics, diffusion, and crystallography

- Ability to Solve real time engineering problems related to microstructure evolution and microstructure-property relationships
- An ability to function on multi-disciplinary teams
- To gain knowledge of contemporary issues. clearly define and interpret various laws of thermodynamics
- comprehend the role of thermodynamics in solid-phase material systems
- be able to predict any change(s) in the state of a system given few parameters
- demonstrate the ability to describe unary-, binary-, and two-phase systems

Suggested Books

- David V Ragone, *Materials Thermodynamics, Volume 1 of MIT series on Materials Science & Engineering.*
- Gaskell, David R. *Introduction to Metallurgical Thermodynamics,* 1981: Hemisphere Pub. Corp.
- James E. House, *Principles of Chemical Kinetics, 2nd Edition, Academic Press, 2007.*

MSE-231 X Ray Diffraction and Crystallography

Credit Hours: 3-0

Pre-requisites: MSE101-Fundamentals of Engineering Materials

Course Objectives

The course is designed to introduce x-ray diffraction as a tool for materials characterization. The specific course objectives are:

- Electromagnetic radiation, Continuous/Characteristic spectrum, Absorption
- Types of lattices, Miller notation, Symmetry operators, Stereographic projection
- Bragg's law, Diffraction methods
- X-ray scattering (electron, atom, unit cell), structure/multiplicity factor, Examples
- Phase identification by x ray diffraction
- Crystal structure determination, Indexing

Course Contents

- Fundamentals of X Ray Diffraction Theory .
- Introduction to crystal systems & Designation of points, lines and planes, directions,crystal structures of common metals and ceramics,
- stereographic projection.
- Diffraction from amorphous structures
- Diffraction from crystals
- Debye formula for powder diffraction
- Diffraction from very small crystals
- Diffraction by an imperfect crystal lattice
- Displacement disorder in lattices
- Mixed crystals and substitution disorder.
- Small Angle X Ray Scattering (SAXS)::

Course Outcome

At the end of the course the students are expected to have learned the following:

- Usage of x rays in crystallography
- Diffraction methods and applications in materials characterization
- Phase identification and crystal structure determination

Suggested Books

- B.D. Cullity, S.R. Stock, and Stuart Stock, *Elements of X-Ray Diffraction (3rd Edition), Addison Wesley Series in Materials Engineering*
- Guinier *X-Ray Diffraction: In Crystals, Imperfect Crystals, and Amorphous Bodies,*
- *W. H. Freeman and Company*
- E. Warren, *X Ray Diffraction, Addison-Wesley series in metallurgy and materials engineering*

HU-222 Professional Ethics

Credit Hours: 2-0

Pre-requisites: None

Course Objectives

- To train students in professional ethics in such a way that they are able to apply their knowledge in their respective engineering profession.

Course Contents

- Ethical issues associated with design, use, and propagation of technology
- Ethical dilemmas associated with virtually all stages of development and use, for both creators and users; how such dilemmas are resolved (or complicated) according to how effectively they are communicated to stakeholders
- History of private and public rights in scientific discoveries and applied engineering, leading to the development of worldwide patent systems
- Clauses of invention protectable under the patent laws of the U.S.
- Procedures in protecting inventions in the Patent Office and the courts; review of past cases involving inventions and patents in the chemical process industry and medical pharmaceutical, biological, and genetic-engineering fields
- Devices in the mechanical, ocean exploration, civil, and/or aeronautical fields; the electrical, computer, software, and electronic areas, including key radio
- Solid-state, computer and software inventions; and also software protection afforded under copyright laws.

Course Outcome:

At the conclusion of this course, the student should be able to:

- Live a successful personal life
- Get the ability to deal with the clients
- Perform his professional duties well and ethically.
- Perform his duties with all his best efforts and thinking himself as an asset of working organization.

Suggested Books

- Roger E. Schechter and John R. Thomas, *Principles of Patent Law, 2nd Edition, WEST a Thomson Business Publication*
- Perelman, Leslie C., James Paradis, and Edward Barrett. *The Mayfield Handbook of Technical and Scientific Writing*. McGraw-Hill, 1997.

MATH-351 Numerical Methods

Credit Hours: 3-0

Pre-requisites: MATH-121

Course Objectives

- To enable students using structured programming techniques in suitable programming languages and implement numerical solutions using computer- based techniques.
- Numerical methods of solving problems arising in heat and mass transfer, fluid mechanics, chemical reaction engineering, and molecular simulation. Topics: direct and iterative methods for linear systems, numerical linear algebra, solution of nonlinear algebraic equations, systems, system of nonlinear equations and ordinary differential equations, systems of differential equations, solution (e.g. Navier-Stokes) interpolation & extrapolation techniques, numerical differentiation and numerical integration.

Course Contents

- An advanced introduction to numerical linear algebra
- Direct and iterative methods for linear systems
- Eigenvalue decompositions and QR/SVD factorizations
- Stability and accuracy of numerical algorithms
- The IEEE floating point standard, sparse and structured matrices, preconditioning, linear algebra software

Course Outcome

- After this course student will be able to use mathematics as a strong tool to understand and develop the practical problems which they come across in Engineering/Technology.

Suggested Books

- Richard L Burden, J. Douglas Faires Numerical Analysis, Cengage Learning Publishers, 2011 9th Edition.
- John H. Mathews and Kurtis D. Fink, Numerical Methods 4th Edition, 2004 Prentice-Hall Pub.Inc.

MSE-202 Materials Engineering Lab II

Credit Hours: 0-1

Pre-requisites: None

Course Objectives

- To know about the effect of aging on rolled steel, effect of mechanical properties and microstructures and hardness of rerolled steel, Tensile testing, Deformation and Fracture of given specimen.

Course Contents

- The effect of natural aging on the hardness of Al-2024
- The effect of artificial aging on the hardness of Al-2024
- The effect of annealing on the microstructure and hardness of re-rolled steel
- The effect of cooling rate on mechanical properties and microstructure of steel
- Preparation of tensile test specimen, according to ASTM A370-03, and to carry out tensile test
- Observation of the micro-structure of mild steel specimen prior to and after deformation
- Finding the melt flow index of given polymer at different temperatures
- Determination of the impact strength of given metallic sample
- The injection molding of HDPE
- Demonstration of Gel Permeation Chromatography
- The effect of deformation and fracture on hardness of given sample
- The effect of temperature on the viscosity of given polymer

Course Outcome

- Students after attending this course will be able to study the effect of aging on rolled steel, effect of mechanical properties and microstructures and hardness of rerolled steel, Tensile testing, Deformation and Fracture of given specimen.

Suggested Books

- Consult the books related to the subjects covered in semester 4

MSE-224 Deformation & Fracture

Credit Hours: 3-0

Pre-requisites: MSE-101 Fundamentals of Engineering Materials

Course Objectives

- Deformation and Fracture is designed to acquaint the students with the principles of deformation in engineering materials incorporating the mechanisms of elastic deformation, yielding, onset of plastic deformation, strain hardening, necking, crack nucleation mechanisms, crack propagation dynamics and eventually fracture.
- The students are expected to orient themselves with the variability in different engineering materials concerning the deformation mechanisms in each category and fracture mechanics based upon variations in crystal structures in each.

Course Contents

- Deformation by Slip, Dislocation Movement
- Deformation of Single Crystals
- Stress fields and energy of dislocation
- Grain boundaries and dislocation, strain aging, cold working
- Theories of fracture, Fracture toughness, critical stress, measurement of critical stress, stress intensity factor
- Overview of mechanical properties of ceramics, metals, and polymers with emphasis on the role of processing and microstructure in controlling these properties
- Basic topics include: continuum stress and strain, truss forces, torsion of a circular shaft and beam bending, Design of engineering structures

Course Outcome

At the end of the course the students are expected to have learned the following:

- How can a mode of deformation be determined based upon crystal structure and processing history
- What are the different methods of finding the yield point
- How is polymer deformation and fracture different from ceramics and metals
- How do dislocations interact with particles and other dislocations

- How can the yield point be determined based upon strain field around dislocations in single crystals
- How can we theoretically determine the yield point in polycrystalline materials
- How long a material with a crack can perform during service before catastrophic failure

Suggested Books

- R. W. Hertzberg, *Deformation and Fracture Mechanics of Engineering Materials*, 5th Edition Wiley Global Education, 2012
- J. P. Hirth, J. Lothe, *Theory of Dislocation, McGraw Hill Publications*

MSE-222 Phase Transformation and Equilibria

Credit Hours: 3-0

Pre-requisites: MSE-221 Materials Thermodynamics & Kinetics

Course Objectives

The course offers insight into the important field of phase transformations in metals and alloys. The specific course objectives are:

- Underlying thermodynamics, Gibb's Free energy
- Binary solutions, Phase diagrams and heterogeneous systems
- Diffusion, Types of transport, atomic mobility, carburization of steel
- Crystal interfaces/microstructure, Grain boundary migration/mechanics, types of interfaces
- Solidification, Nucleation and growth
- Diffusional and non-diffusional transformations in solids.

Course Contents

- Thermodynamics and Phase Diagrams
- Binary solutions
- Binary Phase Diagrams
- Equilibrium in Heterogeneous systems
- Ternary equilibrium
- Diffusion
- Crystal Interfaces and Microstructures
- Special High Angle grain boundaries
- Phase coherence, second phase interface energy, solidification and heat flow
- Eutectic solidification
- Diffusional transformation in solids, eutectoid transformations
- GP zones, Diffusion less transformations
- Martensitic transformation, glass transformation, spinodal decomposition

Course Outcome

- At the end of the course the students are expected to have learned the following:
- Phase transformations & associated thermodynamics
- Variables influencing development of a particular microstructure in alloys
- Structure-property relationships in view of the fabrication process route

Suggested Books

- David A. Porter and Kenneth E. Easterling, Phase Transformations in Metals and Alloys, Third Edition (Revised Reprint) CRC Press.
- Hats Hilleret, Phase Equilibria, Phase Diagrams and Phase Transformations: Their Thermodynamic Basis, Cambridge University Press 8th Edition 2008.

MSE-241 Polymer Science

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

Students will learn about

- Chains of ordinary Polymers
- States of polymers; viscous, Elastic and Viscoelestic
- Maxwell and Voigts Model
- Crystallization and growth of polymers and their kinetics
- addition or chain growth polymerization
- microstructure of polymers
- solution and other properties of polymers

Course Contents

- Chains of ordinary Polymers, viscous state, Elastic and Viscoelestic states
- Maxwell and Voigts Model
- Crystallizations and Growth
- Kinetics of crystallization, addition or chain growth polymerization
- Polymers with microstructure, copolymers and stereo polymers, properties of polymer solutions, frictional properties, light and radiation scattering by polymers photosensitive polymers.

Course Outcome

- Would be able to understand the polymer structure-property relationship
- Understand elastic and visco elastic properties of polymers
- Correlate the concepts of diffusion and microstructure evolution and solve real time problems

Suggested Books:

- Paul C. Hiemenz, Timothy P. Lodge Polymer Chemistry, Marcel Dekker Publishers, 2nd Edition.
- Joel Fried, Polymer Science and Technology, 3rd Edition Prentice Hall Publishing 2013.

HU-212 Technical & Business Writing

Credit Hours: 2-0

Pre-requisites: None

Course Objectives

To develop and flourish the skills that will enables students to produce clear and effective scientific and technical documents

- Develop skills that will enable you to produce clear and effective scientific and technical documents
- basic principles of good writing-which scientific and technical writing shares with other forms of writing-and on types of documents common in scientific and technical fields and organizations
- oral communication of scientific and technical information

Course Contents

- Develop skills that will enable you to produce clear and effective scientific and technical documents
- Basic principles of good writing-which scientific and technical writing shares with other forms of writing-and on types of documents common in scientific and technical fields and organizations
- Oral communication of scientific and technical information

Course Outcome

- An ability to write final year dissertation and technical papers
- Able to use tools for technical writing
- An ability to prepare oral presentations
- Able to work as a team leader in technical meetings and gatherings
- Understanding the basic principles of good writing-which scientific and technical writing
- Knowledge of other forms of writing-and on types of documents common in scientific and technical fields and organizations
- Developed knowledge and skills of oral communication of scientific and technical information.

Suggested Books

- Markel, Mike. Technical Communication.10th Edition New York, NY: Bedford/St. Martin's, 2012.
- Lance A Parr Report Writing Essentials, 2000 Edition

MSE-303 Materials Engineering Lab III

Credit Hours: 0-2

Pre-requisites: None

Course Objectives

- To know about the Melt Flow Index , Hardness, Impact & Tensile Tests , Introduction to AFM, XRD, Optical Microscopy SEM, XRF, Heat Treatment processes, Particle Size Analysis, Surface area and porosity analysis using BET, Edge & lap joint using Arc Welding, Use of TIG welding technique, Nondestructive testing.

Course Contents

- Melt Flow Index
- Rockwell hardness
- Vickers Hardness Testing
- Atomic Force Microscope
- Demonstration of XRD
- Optical Microscopy of the metallic samples
- Demonstration of SEM
- Demonstration of XRF
- Heat Treatment processes
- Annealing, Normalizing
- Quenching, Air Quenching
- Making of Butt Joint using Arc Welding
- Charpy Impact Test
- Tensile Testing
- Particle Size Analysis
- Surface area and porosity analysis using BET
- Edge & lap joint using Arc Welding
- Use of TIG welding technique
- Nondestructive testing

Course Outcome

Student will have basic idea about Melt Flow Index , Hardness, Impact & Tensile Tests , AFM, XRD, Optical Microscopy SEM, XRF, Heat Treatment processes, Particle Size Analysis, Surface area and porosity analysis using BET, Edge & lap joint using Arc Welding, Use of TIG welding

technique, Nondestructive testing.

MSE-313 Welding and Joining

Credit Hours: 2-0

Pre-requisites: MSE-101 Fundamentals of Engineering Materials

Course Objectives

The course is designed to introduce joining technology techniques to learners and their usage in industrial applications. The specific course objectives are:

- Welding techniques; Oxy-fuel welding, Arc welding processes
- Specialized techniques; Electron beam welding, Laser welding, Diode welding etc.
- Process parameters, weld pool control, comparative performance, HAZ
- Heat flow & chemical reactions in welding
- Laser generation and modeling, Diode operation
- Adhesive bonding methodologies.

Course Contents

- Processes and materials from the viewpoint of their fundamental physical and chemical properties
- Cold welding, adhesive bonding, diffusion bonding, soldering, brazing, flames, arcs, high-energy density heat sources, solidification, cracking resistance, shielding methods, and electric contacts
- Science of non equilibrium transformations during welding
- Adhesion-Cohesion, Riveting, assembly, fastening

Course Outcome

- Understanding of different welding and joining techniques
- Selection a particular technique for a certain application and process parameters to produce a sound weld or joint
- Understand and control the microstructural changes taking place during different welding and joining processes
- Integrated the knowledge of thermodynamics, mass and heat transport and diffusion kinetics to solve the real life engineering problems

Suggested Books

- Harold E Pattee, Technological Advances in Welding and Other Joining Process, Battelle Press.

- Howard Carry and Scott Helzer, Modern Welding Technology, 6th Edition Prentice Hall 2004.

MSE-333- Material Testing Techniques

Credit Hours: 3-0

Pre-requisites: None

Course objectives:

The main objectives of the course are

- Understanding of principles of basic material characterization techniques
- To interpret the results obtained from different characterization techniques
- Understanding to select a certain characterization technique based on type of material

Course Contents

- Mechanical testing; hardness, tensile, compression, torsion, fatigue, creeps and impact testing. Microscopy; metallography, optical microscopy, SEM
- Nondestructive testing; Discontinuities, Visual testing, Penetrant Testing, Magnetic Testing, Radiographic Testing, Ultrasonic Testing, Eddy Current Testing, Thermal Infrared Testing, Acoustic Emission Testing

Course Outcomes

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

- Understand the principles of basic material characterization techniques
- Interpret the results obtained from various material characterization techniques
- Selection a of suitable characterization technique and its parameters to characterize a certain type of material

Suggested Books

- Elton N. Kaufmann, Characterization of Materials, Volume 1 and 2, Wiley, (2003)
- George E. Dieter, Mechanical Metallurgy, 3rd Edition, SI Metric Edition,McGraw-Hill Book Company, (1986)
- Norman E. Dowling, Mechanical Behavior of Materials, 2nd Edition, Prentice Hall, 1999
- Charles J. Hellier, Handbook of Nondestructive Evaluation, 1st Edition, The McGraw-Hill Companies, Inc. (2001)
- Robert E. Green, B. BoroDjordjevic, Manfred P. Hentschel, Nondestructive Characterization of Materials XI,Springer-Verlag, Berlin, Germany, (2003)
- Robert Cahn,Concise Encyclopedia of Materials Characterization, 2nd Edition, Elsevier Science, (2005)

MSE-342 Polymer Engineering

Credit Hours: 3-0

Pre-requisites: MSE-241 Polymer Science

Course Objectives

Polymer Engineering is an engineering field that covers manufacturing, designs, analyses, and/or testing of polymeric materials. Polymer engineering covers aspects of petrochemical industry as synthetic polymers are made from monomers derived from this industry, polymerization, structure and characterization of polymers, properties of polymers, compounding and processing of polymers and description of major polymers, structure property relations and applications. Principal purpose of Polymer Engineering course is that students encompass the testing, processing, design, development, and manufacture of polymeric products. Specific objectives of the course of Polymer Engineering are outlined below:-

- To recognize the Challenges, Needs, and Opportunities which are presented by the polymeric materials in today's world both in academia and industry.
- To provide an integrated, complete and stimulating introduction to polymer engineering.
- To bring into one framework the fundamental relationship between structure relationship.
- To introduce the description of major polymeric materials
- To introduce various important testing and characterization techniques.
- To provide insight into polymer processing techniques.
- To enable students to determine the choice and design of polymeric materials by keeping in view a specific targeted applications.

Course Contents

- Manufacturing, properties and applications of Polymers
- Polystyrene, polybutadeine, polyester, poly methyl methacrylate (PMMA), nylon, acrylonytryl-butadeine-styrene (ABS)
- Manufacturing of foams, adhesives, formaldehyde, polyurethane and other advanced polymers
- Testing and identification of polymers, high density and high molecular weight polymers, polymeric fibers

Course Outcome

At the end of the course the students are expected to have learned the following:

- How to determine/design which polymeric materials can be appropriate to meet the demand of a specific engineering application.
- How to determine which technique would be useful for analysis and characterization
- To understand the Structure-property relationships of polymeric materials
- To understand the fundamental of polymeric processing, modifications and engineering principles involved in it.
- Description of major polymers materials, which are vital for in today's world.
- Modern topics in polymer research and applications, in academia and industry
- To carry out a case-study, in which group of student will be given short project to design/determine/modify/characterize the polymer materials for the specific applications.

Suggested Books

- V. Tobolsky Properties and Structure of Polymers, 2nd Edition, John Wiley and Sons
- N. G. McGrum, C. P. Buckley, C. B. Bucknall, Principles of Polymer Engineering, 2nd Edition Chapman and Hall Publishers, 1991

ECO-130 Engineering Economics

Credit Hours: 2-0

Pre-requisites: None

Course Objectives

To impart knowledge of engineering economy.

Course Contents

- Material choice concepts, fundamentals of engineering economics, manufacturing economics modeling methods, and life-cycle environmental evaluation
- Engineering costs and costs estimation
- Interest and equivalence, arithmetic gradient, geometric gradient, economic criteria
- Annual cash flow analysis, rate of return analysis, incremental analysis, uncertainty in future, depreciation, income taxes, inflation and price change
- Selection of a minimum attractive rate of return, economic analysis in the public sector

Course Outcome

- Familiarize with the terminologies used in engineering economics
- Price, Supply, & Demand relationship
- Cost Concepts & Analysis
- Depreciation and Depletion
- Production Concepts & Mathematical Models
- Simplex method
- Problems. Capital Financing and Budgeting
- Partnership & joint stock companies
- Industrial Relations
- Labor organizations

Suggested Books

- William G Sullivan, Elin M Wicks, and James Luxhoj, Engineering Economy (13th Edition), 2005.
- De Neufville, R. Applied Systems Analysis: Engineering Planning and Technology Management 2nd Edition McGraw-Hill, 1990.
- Ashby, M. F. Materials Selection in Mechanical Design. 3rd Edition. Elsevier, 2005.
- Donald G. Newnan, Ted Eschenbach, and Jerome P. Lavelle, Engineering Economic Analysis, Oxford University Press 2006.

ME-312 Measurement and Instrumentation

Credit Hours: 2-0

Pre-requisites: None

Course Objectives

The primary objective of this course is to provide students with in-depth knowledge of instruments and measurements in the field of Material Science & Engineering. Following are the course objectives:

- To develop engineers with intellectual, imaginative and engineering skills.
- To provide knowledge on the fundamentals of measurement science and measuring instruments.

Course Contents

- Feedback Process Control
- Process characteristics and controllability
- Process pressure measurement instruments
- Understanding the effects of gravity, Pressure gauges, level and density measurements, flow measurements
- Temperature and humidity measurements, calibration, electrochemical measurements
- Calibrations in terms of concentration, pneumatic control mechanism, electronic control systems, logical and numerical controls
- Programmable logic controls (PLC's), Actuators and Valves

Course Outcome

- Learn basic principles of instruments used in materials processing and characterization
- Calibration of instruments
- Understanding the effects of gravity, Pressure gauges, level and density measurements, flow measurements, Temperature and humidity measurements, electrochemical measurements
- Knowledge of logical and numerical controls, programmable logic controls (PLC's), Actuators and Valves.

Suggested Books

- Curtis Johnson Process Control Instrumentation Technology 8th Edition Pearson/Prentice Hall, 2006.
- Norman A Anderson, Instrumentation for Process Measurement and Control, 3rd Edition CRC press 1997.

MSE-304 Materials Engineering Lab IV

Credit Hours: 0-2

Pre-requisites: None

Course Objectives

To know about Fabrication and tensile, Impact, bend testing of composites, and various parameters effecting the corrosion of steel samples, Use of Positional Resistance Transducers Wheatstone Bridge Measurement, Temperature Sensors, light Measurement, Linear Position or Force Application, Rotational speed or position Measurement, Sound Measurements, Use of the critical speed of Ball Mill, Surface energy study by using Ball Mill, Sample preparation for Gamry® Setup.

Course Contents

- Fabrication and tensile, Impact, bend testing of composites
- Effect of Moisture on mechanical properties of composite
- Corrosion Electrical conductivities of liquids, localized corrosion effects, effect of pH of solutions on corrosion rate of steel samples
- The effect of concentration of solutions on corrosion rate of steel samples
- The effect of mechanical working / stresses on rate of corrosion of steel samples
- Positional Resistance Transducers Wheatstone Bridge Measurement
- Temperature Sensors, light Measurement
- Linear Position or Force Application
- Rotational speed or position Measurement
- Sound Measurements
- The critical speed of Ball Mill, Surface energy study by using Ball Mill, Sample preparation for Gamry Setup / Cold mounting of small complex samples
- The corrosion rate with the help of Gamry® EChem framework Euro Cell kit (Demonstration)

Course Outcome

- Student will be able to fabricate and test the composites, and will be able to observe the various parameters effects on the corrosion of steel samples,
- Use of Positional Resistance Transducers Wheatstone Bridge Measurement,
- Temperature Sensors, light Measurement,

- Linear Position or Force Application,
- Rotational speed or position Measurement,
- Sound Measurements,
- Use of the critical speed of Ball Mill,
- Surface energy study by using Ball Mill,
- Sample preparation for Gamry Setup.

MSE -326 Corrosion & Protection

Credit Hours: 3-0

Pre-requisites: MSE-213 (Metal and Alloys-1)

Course Objectives

- Provide fundamental understanding of aspects of electrochemistry and materials science relevant to corrosion phenomena.
- Provide methodologies for predicting, measuring, and analyzing corrosion performance of materials.
- Identify practices for the prevention and remediation of corrosion.

Course Contents

- Free energy and the criterion for a reaction to occur at constant T,P.

- Definition of electrical potential. Hydration of Ions. Structure of Interface between Metal/Aq.

- Soln.Existence of Interface Potential Difference. Rate of Electrochemical Reaction. Use of Red-Ox curves to "predict" corrosion. Mechanism of oxidation of metals in aqueous solutions. Equilibrium Reduction Potential. Reduction reactions during corrosion of metals. Thermodynamic Driving Force for Corrosion. Behavior of Noble Metals. Stability of Anions in Aqueous Solutions.

- Exchange Current Density. Galvanic coupling. Measurement of kinetics of Red-Ox reactions as a function of potential. Reference electrodes. Mechanism of active corrosion of iron. Effect of specific anions on the corrosion of iron. Formation of solid corrosion products. Pourbaix Diagrams. Corrosion Inhibitors.

- Corrosion protection by coatings. Passivity.Pitting Corrosion. Crevice corrosion. Influence of microstructure on corrosion (sensitization of stainless steel). Stress corrosion cracking. Corrosion fatigue. Hydrogen assisted cracking. Fretting corrosion. Atmospheric corrosion. Corrosion in concrete. Anodic protection. Cathodic protection. Stray current corrosion.

Course Outcomes

The successful student will:

- Understand the origin of the difference in electrical potential across an interface, in particular, a metal/electrolyte interface.
- Understand the relationship between rates of electrochemical reactions and the potential drop across interfaces.
- Understand the causes of and the mechanisms of various types of corrosion, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, and various modes of environmentally assisted cracking.
- Be knowledgeable of the influence of a material's composition and microstructure on its corrosion performance.
- Be knowledgeable of the effect of an electrolyte's composition on the corrosion of metals.
- Be able to identify materials that will exhibit adequate corrosion resistance in a particular environment.
- Be able to propose economically viable remedial actions that will eliminate or reduce corrosion to a tolerable level.

Suggested Books

- M G Fontana, Corrosion Engineering, 3rd Edition, McGraw-Hill, (1986)
- K R Trethewey& J Chamberlain, Corrosion for Science & Engineering, 2nd Edition, Longman, (1995)
- Pierre R Roberge, Corrosion Engineering; Principles and Practice, McGraw Hill Professional, (2008)

MSE-461 Composite Materials

Credit Hours: 3-0

Pre-requisites: MSE101-Fundamentals of Engineering Materials

Course Objectives

The course is designed to deal primarily with the fundamental aspects of the composite materials, their processing and manufacturing methods. The main objectives of the course are:

- To introduce the rudimentary concepts of the composite systems and their classifications.
- To understand the properties and their specific applications
- To introduce the manufacturing and processing methods of forming composite materials.
- To study the reinforcement effect of fillers in the matrix for the development of composite systems.

Course Contents

- Introduction to Composite materials
- Classification, Mechanical Behavior, potential advantages, specific stiffness and strength
- Types of polymer Matrix composites, glass fiber and carbon fiber composites, processing and manufacturing of polymer matrix composites, ceramic matrix composites, metal matrix composites, machining of composites, specific applications and case studies
- Composites in aerospace applications

Course Outcome

At the conclusion of this course, the student should have develop knowledge of:

- Nature of reinforcing materials - fibers, whiskers, platelets, etc.
- Overview of mechanical and physical properties of a range of composite materials systems
- Fabrication of composite materials, and how this relates to microstructure and properties
- How new materials are developed and become accepted by industry Develop skills in:
- Assessment of the applicability of a specific material for a specific application Rational selection of materials
- Self-directed learning, incorporating researching properties of commercial materials

Suggested Books

- Richard M. Christensen, Mechanics of Composite Materials, Dover Publications, Incorporated, 2005.
- Krishan K. Chawla, Composite Materials: Science and Engineering, 3rd Edition, Springer Publishing House 2012.

MSE-351 Ceramics & Glasses

Credit Hours: 3-0

Pre-requisites: MSE101-Fundamentals of Engineering Materials

Course Objectives

The course is designed to study the unique properties of structural and functional ceramics and glasses including ferroelectric, piezoelectric and magnetic ceramics, clays, porcelains and refractories. The main objectives of the course are:

- To introduce the rudimentary concepts about ceramics and glass materials.
- To understand the structure and properties of ceramics and glasses
- To introduce the manufacturing and processing methods of ceramics and glasses.

Course Contents

- Physical, Thermal, Electrical and Mechanical Properties of Ceramics
- Ceramic Crystal Structures
- Processing of Ceramic Powders
- Sintering Kinetics
- Hot pressing
- Hot Isostatic Pressing
- Over pressure sintering
- Phase Transformation in Ceramics
- Engineering Ceramics in Chemical Processes
- Filters, Machining of Ceramics and Near Net Shape Manufacture
- Kinetics of Glass Transition
- Fictive Temperature
- Factors influencing glass transition
- Viscous and Visco-elastic behavior
- Phase Transformation in Glasses
- Glass production Techniques and Heat Treatment of Glasses

Course Outcome

At the conclusion of this course, the student should have develop knowledge of

- How a range of ceramic materials and glasses are made and what are the critical steps in

these processes

- How ceramic and glass processing is used to control and modify microstructure.
- How ceramic microstructure controls the subsequent properties of a material.
- Understand materials design, materials selection and new developments in ceramic science.
- Understanding of different physical and chemical properties of ceramics
- Understanding of crystal structures of ceramic materials
- Process and Process parameters selection
- Learn about ceramics processing techniques and sintering mechanisms
- Controlling properties using heat treatment of glasses

Suggested Books

- Michel Barsoum, Fundamentals of Ceramics, McGraw Hill Publications
- W. D. Kingery, H. K. Bowen, D. R, Uhlmann, Introduction to Ceramic, 2nd Edition John Wiley and Sons 1996.
- James, Reed, Principles of Ceramic Processing, 2nd Edition, 1995, John Wiley and Sons
- M. N. Rahaman, Ceramic Processing, Taylor & Francis, 2006.

MSE-404 Design of Experiments & Data Analysis

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- Develop understanding of the subject
- To understand the nature of variability.
- To understanding of the principles of statistical inference.
- To apply statistical inference and control charts to applications.
- To understand assumptions and limitations of DOE.
- To conceive and conduct a designed experiment to characterize a process

Course Contents

- Statistics review, control charts; design and analysis of experiments
- ANOVA, Factorial experiments
- Response surface modeling, regression, yield modeling
- Advanced process control: spatial modeling, run-by-run control, real-time control
- Six sigma analysis, risk analysis and management; reengineering and process design

Course Outcome

- Design and analysis of experiments
- ANOVA
- Factorial experiments
- Response surface modeling, regression, yield modeling, Advanced process control: spatial modeling, run-by-run control, real-time control
- Six sigma analysis
- risk analysis and management
- reengineering and process design

Suggested Books

- Jiju Antony, Design of Experiments for Engineers and Scientists, Revised Edition Butterworth-Heinemann, 2003
- Robert O. Kuehl Design of Experiments: Statistical Principles of Research Design and Analysis, 2nd Edition, Duxbury/Thomson Learning, 2000

MGT-401 Total Quality Management

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- To provide in-depth knowledge of the subject.
- This subject will provide students with an introduction to the major theories and model in quality management.
- Through discussion and case studies, tutorials will examine how these theories can be applied in organizational settings.

Course Contents

- Total quality management and revival of quality
- Management systems, information and analysis
- Organizational implications, shortcomings of the accounting system
- Organizational linkages, information systems, quality planning, service quality
- Human resource development and quality management, training and development, management of process quality, statistical quality control

Course Outcome

On successful completion of this subject,

- Explain the derivation of the quality management philosophy from a historical perspective.
- Explain models of quality management and analyze the relationship between total quality management (TQM) and ISO 9001-2000 quality systems certification.
- Apply empirical evidence and evaluate quality management concepts, principle, tools and techniques.
- Critically evaluate major theories and models of organizational problems, as presents in case studies.
- Analyze the impact of quality management practices on organizational performance.

Suggested Books

- Vincent K. Omachonu and Joel E. Ross, Principles of Total Quality, 3rd Edition, 2004, CRC Press.
- David L. Goetsch and Stanley B. Davis, Quality Management: Introduction to Total Quality Management for Production, Processing, and Services 4th Edition Prentice Hall.

MSE-405 Materials Engineering Lab V

Credit Hours: 0-2

Pre-requisites: None

Course Objectives

- To know about the various nondestructive testing techniques

Course Contents

- Demonstration, calibration of digital ultrasonic flaw detector and thickness measurement of different given samples
- Dye Penetrant Testing
- Detection of flaws in given sample using digital ultrasonic flaw detector
- Leakage testing by DPT technique
- Detection of flaws in given sample using digital ultrasonic flaw detector
- SOP of lab equipment
- Program evaluation technique
- Work break down structure
- Critical path method, Soldering and Brazing
- TIG welding using filler rod
- TIG welding using filler stainless steel rod

Course Outcome

- After attending this course students will be able to use ultrasonic flaw detector Dye Penetrant Testing, Detection of flaws in given sample using digital ultrasonic flaw detector, Leakage testing by DPT technique,
- Detection of flaws in given sample using digital ultrasonic flaw detector, SOP of lab equipment, Program evaluation technique, Work break down structure, Critical path method, Soldering and Brazing , TIG welding using filler rod, TIG welding using filler stainless steel rod

Suggested Books

HU-101 Islamic Studies

Credit Hours: 2-0

Pre-requisites: None

Course Objectives

This course is aimed at:

- To provide basic information about Islamic studies
- To enhance understanding of the students regarding Islamic civilization
- To improve students skill to perform prayers and other worships
- To enhance the skill of the students for understanding of issues related

Course Contents

- Introduction to Quranic studies, Study of selected text of Holy Quran
- Seerat of Holy Prophet(s.a.w)
- Introduction to Sunnah, Selected study from text of hadith
- Introduction to Islamic law & jurisprudence, Islamic culture & civilization, Islam & science, Islamic economic system
- Political system of Islam, Islamic history
- Social system of Islam

Course Outcome

Student will have an introduction to Quran, Seerat of Holy Prophet, Knowledge of hadith, to Islamic law & jurisprudence, Islamic culture & civilization Islam & science, Islamic economic system, Political system of Islam, Islamic history Social system of Islam.

Suggested Books

- Burki, Shahid Javed. State & Society in Pakistan, the Macmillan Press Ltd 1980.
- Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi: Oxford University Press, 2000.
- S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
- Mehmood, Safdar. Pakistan Political Roots & Development, Lahore, 1994.
- Wilcox, Wayne. The Emergence of Bangladesh, Washington: American Enterprise, Institute of Public Policy Research, 1972.
- Mehmood, Safdar. Pakistan Kayyun Toota, Lahore: Idara-e-Saqafat-e-Islamia, Club Road.
- Amin, Tahir. Ethno -National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.

- Ziring, Lawrence. Enigma of Political Development. Kent England: W M Dawson & sons Ltd, 1980.
- Zahid, Ansar. History & Culture of Sindh. Karachi: Royal Book Company, 1980.
- Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
- Sayeed, Khalid Bin. The Political System of Pakistan. Boston: Houghton Mifflin, 1967.
- Aziz, K.K. Party, Politics in Pakistan, Islamabad: National Commission on Historical and Cultural Research, 1976.
- Muhammad Waseem, Pakistan under Martial Law, Lahore: Vanguard, 1987.

MGT-271 Entrepreneurship

Credit Hours: 2-0

Pre-requisites: None

Course Objectives

- Entrepreneurship is an important component in the process of economic development.
- The purpose of this course is to analyze the theories of entrepreneurship and to go for case studies of successful entrepreneurs.

Course Contents

- Theory of the Firm, theory of capital markets, legal characteristics of corporation
- Corporate charters, the structure of corporate law, financing of corporation, Board of Directors and duties, management duties and takeover defenses, securities regulation.
- Milestones for successful venture planning, strategy Vs Tactics from a venture planner, commercializing technology.

Course Outcome

- Industrial economic strategy
- Preparation of a business plan for new ventures and financing options for start-up businesses
- Barrier to entry, corporate governance and mergers Information gained through environmental scans on new business opportunities
- Case studies
- Sharing the experiences of entrepreneurs and investors
- Consulting for or inventing in start-up or entrepreneurial businesses and for professionals.

Suggested Books

- Neal R. Bevans, *Business Organizations and Corporate Law*
- Roberta Romano, *Foundations of Corporate Law, Foundation Press, 1993*
- Robert D Hisrich, Michael P Peters, and Dean A. Shepherd, *Entrepreneurship, 2006*

MSE-463 Nano-Materials

Credit Hours: 2-0

Pre-requisites: PHY-213 Physics of Materials

Course Objectives

- To provide students with the general concepts of nanomaterials.
- To introduce various forms of nanomaterials.
- To provide students with basic principles of nanomaterial preparation.
- To introduce on basic level some of the tools used to characterize nanomaterials.
- To introduce various examples of engineering applications of nanomaterials.

Course Contents

- Introduction to Nanoscience (Potential for nano scale engineering, molecular forces)
- Surface Science for Nanomaterials (e.g. thermodynamics at nanoscale)
- Synthesis of Nanoparticles and Their Self-Assembly.
- Characterization of nano materials, safety concerns
- Thin-Film Deposition.
- Nanolithography.
- Nanomaterials Properties and Applications

Course Outcome

- The course is designed to introduce important concepts of nanomaterials.
- Students will be able to comprehend the potential impact, in all classes of materials, of the control of nanostructure
- Outline the nanotechnology production routes currently available
- Identify possible opportunities for nanomaterials in product development and enhancement.

Suggested Books

- Wing Kam Liu, Eduard G. Karpov, and Harold S. Park, Nano Mechanics and Materials: Theory, Multiscale Methods and Applications, John Wiley and Sons 2006.
- John Vacca, Nanotechnology: Materials, Systems, and Processes at the Nano- Scale, Butterworth Heinmann 2009.

MSE-371 Interfacial Phenomena

Credit Hours: 3-0

Pre-requisites: None

Objectives

- To understand the principal and chemical phenomenon taking place at interface management practices on organizational performance.

Course Contents

- Surfaces in materials, physics of solid surfaces, theoretical models for adsorption, spectroscopic and other techniques for studying adsorption
- Interfacial flow, stationary liquid layers, interfacial oscillations and waves
- Instabilities of parallel flows and films
- Influence of lateral boundaries
- Ion surface interactions, electron surface interactions
- Photon surface interactions, chemistry of surfaces

Course Outcome

- Understand the physics and chemistry of solid surfaces
- Learn different techniques to study different interfacial phenomenon.
- Learn how different species interact with surfaces.
- To manipulate interfacial characteristics for different application.

Suggested Books

- Alexander A. Nepomnyashchy, Manuel G. Velarde, and Pierre Colinet, Interfacial Phenomena and Convection, Chapman and Hall/CRC, 2002.
- Helmut Dosch, Critical Phenomena at Surfaces and Interfaces, Springer, 1992.
- Robert J. Nemanich, P. S. Ho, and S. S. Lau, Thin Films: Interfaces and Phenomena, Materials Research Society, 1986.

MSE-316 Foundry Engineering

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

Course Contents

- Casting versus other shaping/forming processes.
- Types of foundries. Flow of foundry operations. Pattern making, type and properties of molding sands, bonding materials, testing of sands, cores and core materials.
- Foundry moulds' classification and their manufacturing, sand and permanent molding processes, permanent and expendable pattern mould types, melting furnaces and their types, characteristics of liquid metals, solidification and heat transfer, metal flow, shrinkage and contraction, flow of metals in molds, gating and riser systems and design, metal gas interaction, cleaning of casting, casting defects, inspection and quality assurance, ferrous and non- ferrous casting techniques, alloy making.
- Casting techniques: sand molding, plaster molding, CO2 molding, V-process, magnetic molding, investment casting, evaporative pattern casting, centrifugal casting, die casting, continuous casting, squeeze casting, casting of single crystals.
- Use of Solid cast for modeling and simulation of solidification.

Course Outcome

Suggested Books

- Richard W. Heine, Carl R. Loper, Philip C. Rosenthal, Principles of metal casting, 2nd Edition, Tata McGraw-Hill, (2001)
- Peter Beeley, Foundry Technology, 2nd Edition, Butterworth Heinemann (BH), (2001)
- Howard F. Taylor, Foundry engineering, Wiley, (1959) (Digitized in 2007

MSE-325 Heat Treatment of Materials

Credit Hours: 3-0

Pre-requisites: MSE-222 (Phase Transformation and Equilibria)

Course Objectives

- To explain different equilibrium and non-equilibrium phase transformations
- To familiarize with different heat treatment processes carried out to improve surface and bulk properties.

Course Contents

Introduction and applications of Iron-carbide (I-C) diagram and TTT diagrams, Process of heat treatment, Annealing, Normalizing, Hardening, Tempering, Case Hardening (Carburizing, Nitriding, Carbonitriding), Surface Hardening (Flame hardening, Induction hardening, Laser hardening), Thermo-mechanical treatment of steels (Ausforming, Isoforming, Cryoforming), Heat treatment of stainless steels and cast irons, Al alloys, Cu alloys, Ti alloys.

Course Outcomes

The student should be able to,

- Describe different phases formed/found in steels, understand mechanisms governing their formation and explain effect of alloying additions on kinetics of phase transformation.
- Demonstrate a comprehensive understanding of bulk heat treatment processes and be able to apply these treatments for microstructure optimization in order to induce desired mechanical properties for specific industrial application.
- Explain surface hardening and case hardening methods and be able to apply them to obtain desired surface properties. In addition, the student should also be able to apply different case depth measurement methods.
- Comprehend relationships between different thermo-mechanical treatments and apply them to engineer microstructure and mechanical properties.
- Predict and evaluate appropriate heat treatment cycles to induce suitable mechanical properties in stainless steels, tools steels, maraging steels and powder metallurgy parts.

Suggested Books

- George Krauss, Steels: Processing, Structure, and Performance (Principles of heat treatment of steels), 2nd Edition, ASM International, (2015)
- G.M. Russel,J.L. Smith,S.C. Bhatia, Heat Treatment Of Metals, Volume – 1, CBS Publishers & Distributors Pvt. Ltd, (2012)
- George E. Totten, Steel Heat Treatment: Metallurgy and Technologies, 2nd Edition, Press CRC, (2006)
- Vijendra Singh, Heat Treatment of Metals, 2nd Edition, Standard Publishers Distributors, (2006)

MSE-474 Surface Engineering of Materials

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

Surface Engineering is an interdisciplinary and engineering field that covers thin films fabrication, investigation of their performances, designs, analyses, characterization and applications of engineering surfaces.

Course Contents

Elements of material surface interactions, surface tension, Young's sessile drop model, particle surface interactions, surface analysis by ions, electrons and photons, Physical vapor deposition, Chemical vapor deposition, Application of laser and Plasma for surface modification, Characterization of coatings for surface hardness, wear resistance, adhesion and microstructure, Coatings for corrosion resistance, aesthetic appearance, optical and electronic applications, Electroplating, Electro-less Deposition.

Course Outcome

Once the semester is over, the students would be able to:

- Effectively describe any surface in terms of its crystal structure and physical properties
- Explain the importance and relevance to different modification techniques to certain applications
- Describe salient features of various surface modification techniques
- Suggest ways to change/modify surface using thin film deposition techniques
- Explain working principle and interpret information obtained using surface analysis techniques

Suggested Books

- J. B. Hudson, Surface Science:An Introduction, John Wiley and Sons, Inc. (1998)
- W. D. Sproul, K. O. Legg, Opportunities for Innovation: Advanced Surface Engineering , Taylor & Francis,(1994)

MSE-373 Tribological Phenomena on Surfaces

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- To know about the Physical properties of lubricants such as viscosity, composition of lubricants and term and laws concerning lubricants.

Course Contents

- Physical properties of lubricants, viscosity, viscosity shear rate relationship
- Viscosity measurements, temperature characteristics of lubricants
- Composition of lubricants, hydrodynamic lubrication, continuity of flow in a column, bearing geometry and load capacity
- Computational hydrodynamics, hydrostatic lubrication, boundary an extreme pressure lubrication
- Fundamentals of contact between solid surfaces, surface wear and treatment,
- Abrasive, erosive and cavitational wear, adhesive wear, corrosive and oxidative wear, fatigue wear

Course Outcome

Students will be able to comprehend the basic of physical properties of lubricants such as viscosity, composition of lubricants, hydrodynamic lubrication, continuity of flow in a column, bearing geometry and load capacity, computational hydrodynamics, hydrostatic lubrication, boundary an extreme pressure lubrication, fundamentals of contact between solid surfaces, surface wear and treatment, abrasive, erosive and cavitational wear, adhesive wear, corrosive and oxidative wear, fatigue wear.

Suggested Books

- Gwidon Stachowiak and A W Batchelor, Engineering Tribology, 3rd Edition, Butterworth and Heinman 2011.
- Bharat Bhushan, Introduction to Tribology, 2nd Edition, John Wiley and sons, 2013.

MSE-381 Industrial Safety

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

To familiarize the students with basic concepts regarding safety and risk management systems.

Course Contents

- Industrial Safety and risk management an integrated approach, regulations and professional responsibilities
- Risk assessment, human factors, causes of industrial disasters and lessons learned thereof, implementing a safety program
- Concept of hazard avoidance, use of information systems
- Process safety, Buildings and infrastructure, environmental control and noise safety, flammable and explosive materials
- Personal safety and first aid, Fire protection

Course Outcome

- Familiarize the students with different causes of industrial disasters.
- Implement safety programs.
- Familiarize with regulation and professional responsibilities
- Learn about personal safety, first aid and fire protection etc.

Suggested Books

- Laird Wilson, Doug McCutcheon, and Doug McCutcheon, Industrial Safety and Risk Management, University of Alberta Press, 2003.
- C. Ray Asfahl, Industrial Safety and Health Management, 5th Edition, Pearson Education, 2011.

MSE-382 Design Standards & Quality Assurance

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

Following are the major objectives of the course:-

- To create Quality Conscious Culture among the students at each stage.
- To realize execute and implement different quality standards.
- Importance of Quality at designing stage by Material engineers.
- Quality awareness models and standards at international levels.

Course Contents

- Operation Analysis
- Work design
- Workplace, equipment and tool design
- Work environment design, time study
- Performance rating, allowances
- Predetermined time systems, work sampling
- Quality Basics
- Teams and understanding quality improvement
- Customer supplier relationships, incremental and breakthrough improvement, improvement cycles

Course Outcome

After studying this course students are expected to know about following:-

- Importance of Quality at all levels.
- Importance of TQM in design parameters.
- International Quality Standards and award models.
- Importance of TQM as material Engineer.

Suggested Books

- Benjamin Niebel and Andris Freivalds, Methods, Standards, & Work Design, 11th Edition, 2003, McGraw Hill Publications.
- John E., Ed. Bauer, G. L. Duffy, R. T. Westcott, Quality Improvement Handbook, 2nd Edition, American Society for Quality, 2006.

MSE-383 Operations Research

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- To know about general overview of the Operations research Modeling Approach, Deriving Solutions from the Model,
- Introduction to linear programming, the theory of the simplex model, the revised simplex model.

Course Contents

- Overview of the Operations research Modeling Approach
- Deriving Solutions from the Model
- Introduction to linear programming, the theory of the simplex model, the revised simplex model
- Duality theory and sensitivity analysis, the transportation and analysis problems, network optimization models
- The minimum spanning tree problems, the maximum flow problem, the minimum cost flow problem
- A network model for minimizing a projects time-cost tradeoff, non linear programming, Multivariable optimization

Course Outcome

- Students will have an overview of the Operations research Modeling Approach, Deriving Solutions from the Model, Introduction to linear programming,
- The theory of the simplex model, the revised simplex model.

Suggested Books

- Hillier and Lieberman, Introduction to Operations Research, 8th Edition, 2005, McGraw Hill Publications.
- Hamdy A. Taha, Operations Research: An Introduction 7th Edition, Prentice Hall, 2002.

MSE-471 Vacuum Technology in Surface Engineering

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- This course is specifically designed to make the students understand the importance, processes involved and instrumentation with vacuum science and surface engineering. Physical and chemical aspects of Vacuum physics in engineering the surfaces.

Course Contents

- Introduction to Physical Vapor Deposition (PVD), Adsorption and Condensation
- Principles of High Vacuum
- Operation Principles of Vacuum Pumps and Gauges
- Evaporation Sources
- Pulsed Laser Deposition
- Sputtering Discharges
- Plasma Sputtering
- Chemical Vapor Deposition
- Physically Enhanced Chemical Vapor Deposition (PECVD)
- Low Pressure Chemical Vapor Deposition (LPCVD), Ion plating and Ion Beam Assisted Deposition, Film Growth, Micro and Nano structure of films. Post Deposition Processing. Testing of films

Course Outcome

- The course comprises of vacuum physics basic concepts, thin film deposition processes, testing and characterization of films by chemical and mechanical methods of characterization of films

Suggested Books

- John E. Mahan, Physical Vapor Deposition of Thin Films, John Wiley and Sons, 2000.
- Donald M. Mattox, Handbook of Physical Vapor Deposition (PVD) Processing (Materials Science and Process Technology Series) Cambridge University Press, 2007.
- K.S. Sree Harsha, Principles of Vapor Deposition of Thin Films, Elsevier Science, 2006.

MSE-472 Surface Analysis and Characterization

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- To understand surface crystallography and defects compared with bulk crystalline solids
- To introduce various surface modification techniques
- To present fundamentals of thin film technology with emphasis on select thin film deposition processes
- To foster sound knowledge of some of the modern surface characterization techniques

Course Contents

- Measurement of Surface tension and Surface Stress
- Contact Angle techniques and measurement
- Ion Mediated and Van Der Vaal Forces through Atomic Force Microscope, measurement through electro-osmosis
- X Ray Photoelectron Spectroscopy (XPS) of surface
- Field Ion Microscopy
- Low Energy Electron Diffraction Spectroscopy (LEEDS), Ion Scattering Spectroscopy (ISS)
- Secondary Ion mass Spectroscopy (SIMS)
- Rutherford Back Scattering (RBS)
- Dynamic Light Scattering
- Small Angle X Ray Scattering (SAXS), High Resolution Electron Energy Loss Spectroscopy (HREELS)
- Auger Electron Spectroscopy (AES), Electron Scattering for Chemical Analysis (ESCA)

Course Outcome

Once the semester is over, the students must be able to:

- effectively describe any surface in terms of its crystal structure and physical properties

- explain the importance and relevance to different modification techniques to certain applications
- describe salient features of various surface modification techniques
- suggest ways to change/modify surface using thin film deposition techniques
- explain working principle and interpret information obtained using surface analysis techniques

Suggested Books

- Andrew J. Milling, Surface Characterization Methods: Principles, Techniques, and Applications, Marcel Dekker, 1999.
- Charles Evans, Richard Brundle, and Wilson, Encyclopedia of Materials Characterization: Surfaces, Interfaces, Thin Films (Materials Characterization Series) Gulf Professional Publishing, 1992.

MSE-473 Novel Techniques in Surface Engineering

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- To know about the Numerical Parameters for Characterization of Surface Topography.

Course Contents

- Numerical Parameters for Characterization of Surface Topography
- Novel Characterization techniques
- Gaussian filters, multi scalar filtration methods, calibration procedures for stylus and optical instrumentation
- Calibration procedures for Atomic Force Microscopes
- Interrelationship of 2D and 3D characterization
- 3D Surface Metrology and Characterization of Automotive Engine performance
- Theory of deformation and Flow in Gels, Surface Chemistry and Modification
- Sintering of Gels, Comparison of Sol gel Derived and Conventional Coatings
- Applications of Thin Films and Coatings

Course Outcome

- Students will be able to study the numerical parameters of characterization of surface Topography,

Suggested Books

- Liam Blunt and Xiang Jiang, Advanced Techniques for Assessment of Surface Topography: Development of a Basis for 3D Surface Texture Standards, Kogan Science, 2003.
- C. Jeffrey Brinker and George W. Scherer, Sol-Gel Science: The Physics and Chemistry of Sol-Gel Processing, Gulf Professional Publishing, 1990.

MSE-481 Maintenance Management

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- To know about the basic of maintenance budget, benchmarking, deterioration of assets, Life cycling costing, statistics in maintenance, Project management, Computerized Maintenance Management Systems, and inventory control.

Course Contents

- Maintenance Budget
- Evaluating Maintenance
- Benchmarking
- Deterioration of Assets
- Life Cycle costing
- Reengineering
- Maintenance quality improvement
- Maintenance reliability
- Maintenance information flow
- Statistics in maintenance
- Project management
- CMMS, Computerized Maintenance Management Systems
- Inventory control
- Training Programs in maintenance
- Work order systems
- Preventive maintenance
- Reporting and analysis
- Integration of maintenance management

Course Outcome

Students will be able work on maintenance budget. Benchmarking, Deterioration of Assets, Life Cycle costing, reengineering, maintenance quality improvement, maintenance reliability, maintenance

information flow, statistics in maintenance, Project management, CMMS, Computerized Maintenance Management Systems, inventory control.

Suggested books

- Joel Levitt, Handbook of Maintenance Management, Industrial Press Inc., 2009
- Terry Wireman, World Class Maintenance Management, Industrial Press, 1990

MSE-482 Industrial Economics & Management

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

- This is a rudimentary course for the students of business administration. The focus of attention will be given to learning fundamental principles of management and of managing people and organization in a historical as well as contemporary world.
- Students are expected to develop analytical and conceptual framework of how people are managed in small, medium and large public and private national and international organizations.

Course Contents

- Manufacturing systems
- Production principle
- Transformation of input into output
- Definition of systems
- Decision making
- Structural aspects of manufacturing systems
- Types of production
- Mass production
- Integrated manufacturing and management
- Material and technological information flow
- Product/process planning and design
- Layout planning and design
- Aggregate production planning
- Production scheduling, production control and quality, value and cost
- Manufacturing cost, product cost, profit planning and breakeven analysis
- Capital investment for manufacturing

Course Outcome

- Introduction, overview and scope of discipline

- The evolution and emergence of management
- thought Management functions
- Planning concepts, objectives, strategies and policies
- Decision making
- Organizing; departmentalization, line/staff authority, commitments and group decision making
- Staffing: principles of selection, performance, career planning
- Leading: Motivation, leadership, communication
- Controlling: the system and process and techniques of controlling
- Management and Society: future perspective

Suggested Books

- Katsundo Hitomi, Manufacturing Systems Engineering: A Unified Approach to Manufacturing Technology, Production Management and Industrial Economics, 2nd Edition, 1996, Taylor and Francis, London.
- Walter Rautenstrauch, The Economics Of Industrial Management, Funk & Wagnalls Company in assn. with Modern Industry Magazine, 1949.

MSE483 Plant Design (3 CH)

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

To know about the basic of plant layout design, plant layout specifications, Site Selection, Equipment list and site safety parameters, energy and utility balance.

Course Contents

- The Basics of plant Design, Plant layout specifications, Site selection, Equipment Selection,, Specs and Design, Fundamentals of mass conservation and mass balance, Fundamentals of energy conservation and energy balance, Process control and instrumentation, Safety parameters, Liquid storage tanks, Costing and project evaluation.
- Computer aided design: General steps for HYSYS based modeling, HYSYS based model for Benzene Production, HYSYS based model for Cyclopentane productionBlock Flow Diagrams of the following Industries: Steel industry, Cement, Ceramics, Glass, High Density Polyethylene, Pulps and Papers, Composites, Acid gas Sweetening, Petroleum Refinery.

Course Outcomes

The participants of the course will be get the awareness of the basic of plant layout design, plant layout specifications, Site Selection, Equipment list and site safety parameters, energy and utility balance.

Suggested Books

- Kam W. Li and A. Paul Priddy, Power Plant System Design, Wiley, (1985)
- Ed Bausbacher and Roger Hunt, Process Plant Layout and Piping Design,Reprint Edition, PTR Prentice Hall, (1993)
- W.D. Baasal, Preliminary Chemical Engineering Plant Design, 2nd Edition, Van Nostrand Reinhold Press, (1990)

OTM-454 Project Management (3 CH)

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

To provide understanding of the principles and techniques of project management.

Course Contents

- Concepts of project management, project initiation, methodologies, project proposal process, project proposal document, milestones and deliverables, different kinds of projects and stakeholders, objectives, project plan and project approach, staffing plan, quality plan, deployment plan, organizational plan, monitoring and reporting processes.
- Decision Support System (DSS), Project schedule, project development, managing obstacles and risks, managing communication, integration and testing, project closure, case studies.

Course Outcomes

After completing this course, student should know how to manage a project in industry.

Suggested Books

- Colleen Gorton and Erika McCulloch, Fundamentals of Technology Project Management, MC Press, (2004)
- Harold, Cerner, Project Management: A systematic approach to Planning, Scheduling and Controlling, 9th Edition, John Wiley and Sons, (2006)

MSE-452 Electronic and Magnetic Materials

Credit Hours: 3-0

Pre-requisites: PHY-211Physics of Materials

Course Objectives

- The aim of this course is to learn the science and technology of electronic and magnetic-materials. The application of these materials to devices will also be undertaken.
- The importance of semiconducting and magnetic materials lies in their applications in a wide variety of electronic devices. All the modern electronic appliances use semiconductor devices for their operation. Most of these devices are based on the concept of PN junction.
- The aim of this course is to get familiar with the basics concepts of PN junction and their use under different condition. Similarly the magnetic materials are important due to their applications in house hold equipment to industry.

Course Contents

- Relationships between the performance of electrical, optical, and magnetic devices and the micro-structural characteristics of the materials from which they are constructed
- A device-motivated approach with emphasis on emerging technologies;
- Device applications of physical phenomena including electrical conductivity and doping
- Transistors, photodetectors and photovoltaics, luminescence
- Light emitting diodes
- Lasers, optical phenomena
- Photonics, ferromagnetism, and magnetoresistance

Course Outcome

After completing this course, student will be able to:

- Student will become familiarize with basic properties like the electrical, optical and magnetic and applies these understanding for fabrication electric and magnetic devices.
- Magnetic parameters and the types of the magnetism will be understood. These will help to develop a 06 desired properties

Suggested Books

- Pradeep Fulay, Electronic, Magnetic and Optical Materials, Taylor & Francis Group, 2010.
- Allen Nussbaum, Electronic and Magnetic Properties of Materials, Prentice-Hall, 1967.
- Klaus Schroder, Electronic, Magnetic and Thermal Properties of Materials, M. Dekker, 1978.

MSE-465 Powder Metallurgy

Credit Hours: 3-0

Pre-requisites: MSE-314

Course objectives:

The objectives of the course are

- To introduce the various techniques involved in powder production and characterization.
- To develop a comprehensive understanding of the principles of powder densification and sintering.
- To study the mechanical and functional properties of sintered compacts and correlate with microstructure and processing conditions.

Course contents:

- **Powders synthesis/fabrication:** Powder fabrication, Mechanical, Electrolytic, Chemical, atomization
- **Powders:** Powder characteristics, Average particle size, Particle shape, Flowability, Particle size distribution, Hall density, Arnold density, Tap density
- **Densification:** Powder compaction, Green density, Techniques (CIP, HIP, SPS), Sintering theory, Solid state sintering, Liquid phase sintering, Variables influencing densification, Binders, Post compaction processing.

Course Outcomes:

- Comprehend and explain the different techniques used for metal and alloy powder synthesis and characterization.
- Predict the outcomes of changing parameters on powder size, shape, microstructure and composition of the powders fabricated through atomization process.
- Examine sintered microstructures for mechanical, physical or surface properties of polycrystalline materials.

Suggested Books:

- Randall M. German, Powder Metallurgy, 2nd Edition, Metal Powder Industries Federation, (1994)
- Anish Upadhyaya, Gopal Shankar Upadhyaya, Powder Metallurgy: Science, Technology, and Materials, Taylor & Francis, (2011)
- KatsuyoshiKondoh; Powder Metallurgy, Editied Volume, Publisher: InTech, (2012)
- SeropeKalpakjian, Steven R. Schmid, Manufacturing Engineering and Technology, 6th Edition, Prentice Hall, (2010)

- Mikell P. Groover, Fundamentals of Modern Manufacturing, 4th Edition, Wiley, (2010)

MSE-464 Advanced Materials

Credit Hours: 3-0

Pre-requisites: None

Course objectives:

Course Contents

Biomaterials, Basic chemical and physical properties of biomaterials including metals, ceramics and polymers, Role of microstructural properties in the choice of biomaterials and design of artificial organs, implants and prostheses.heat resistant materials, refractory metals and alloys, intermetallics, Nanostructured materials, fuel cell materials, materials for hydrogen storage, shape memory alloys. Smart materials and functional materials.

Course Outcomes:

Suggested Books

- S.C. Guelcher and O.J. Hollinger, An Introduction to Biomaterials, 2ndEdition.Taylor and Francis, (2005)
- P.P. Charles, F.J. Owens, Introduction to Nanotechnology, Wiley-interscience, (2003)
- M.H. Van de Voorde, G.W. Meetham, Materials for High Temperature Engineering applications, Springer, (2000)
- A.S. Edelstein, R.C. Cammarata, Nanomaterials: Synthesis, properties and applications, IoP, (2001)
- M. Donachie, S. Donachie, Superalloys: A Technical Guide, HIS, (2002)

MSE-362-Introduction to Computational Materials Science

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

This course aims to deliver basic knowledge for the applied usage of the current software's used to solve various problems of the materials engineers.

Course Contents

Introduction to computational materials science and engineering. Development of atomic scale simulations for materials applications. Application of kinetic Monte Carlo, molecular dynamics, and total energy techniques to the modeling of surface diffusion processes, elastic constants, ideal shear strengths, and defect properties. Introduction to simple numerical methods for solving coupled differential equations and for studying correlations. Practical aspects associated to the computation of materials, such as model validation, parallel computing, multiscale modeling, and visualization of large data sets.

Course Outcome

At conclusion of this course students should have the knowledge of:

- Basic usage for modelling and simulation knowledge,
- Analyzing problem and designing solution.
- Basics of structured and modulated programming.

Suggested Books

- Richard Lesar, Introduction to Computational Materials Science: Fundamentals to Applications, 1st Edition, MRS Cambridge Press, (2013)
- Koenraad George FransJanssens, DierkRaabe, Ernest Kozeschnik, Mark A Miodownik, Britta Nestler, Computational Materials Engineering: An Introduction to Microstructure Evolution 1st Edition, Elsevier, (2010)

MSE-485 Metallurgical Plants and Quality Control

Credit Hours: 3-0

Pre-requisites: None

Course Objectives

This subject will provide students with an introduction to the major theories and model of quality management pertaining to metallurgical plants.

Course Contents

Metallurgical plant location, factors affecting location, plant layout, product and process layout analysis, layout comparisons, types of pollutants and their treatment, overview of environmental impacts of iron and steel making, hot rolling, forging, cold rolling, annealing and tempering, coating and plating plants, Environmental friendly metallurgical plants, occupational health and safety impacts of metallurgical plants. Fundamentals of statistics and analysis techniques, probability distributions, AQL, AOQL, L TPD, attributes sampling, variable sampling, selection of proper sampling plan, Reliability and maintainability. Inspection of different types of materials and products for evaluation of quality reliability of flaw detection by non-destructive inspection, Introduction to standards for testing of materials like ASTM, BS, JIS and ISO, Pakistan Standards, Quality assurance for final products, measures for quality control.

Course Outcome

On successful completion of this subject,

- Have the basic understanding for the layout of the metallurgical plant
- Basic understand for the site selection and material selection
- Apply empirical evidence and evaluate quality management concepts, principle, tools and techniques.
- Critically evaluate major theories and models of organizational problems
- Ability to Analyze the impact of quality management practices on organizational performance.

Suggested Books

- T. Jones, Steel Industry and The Environment: Technical and Management Issues, International Iron and Steel Institute, (2000)
- Metals Handbook Vol. 17th, Non-destructive Testing and Quality Control, American Society for Metals USA, (2005)
- M. Nurse, B. Sharon, Metallurgical Plant Makers of The World, Metal Bulletin Books, 4thEdition,(1997)