UNIVERSITY OF THE PUNJAB

NOTIFICATION

It is hereby notified that Syndicate at its meeting held on 15.11.2021 approved the recommendations of the Committee, constituted by the Academic Council at its meeting dated 04.01.2021 regarding approval of revised Courses of Reading for B.Sc. (Engg.) Metallurgy and Materials Engineering Program (Semester System) with effect from the Academic Session 2020 and onwards.

Sd/-

Dr. Muhammad Khalid Khan
Registrar

Admin. Block,
Quaid-i-Azam Campus,
Lahore.

No. D/ 12395 **/Acad.** **Dated:** 31-12-2021

1. Dean, Faculty of Chemical & Materials Engineering.
2. Director, Institute of Metallurgy & Materials Engineering.
3. Chairperson, DPCC
4. Controller of Examinations
5. Director, QEC
6. A.O. (Statutes)
7. Secretary to the Vice-Chancellor
8. Secretary to the Pro-Vice-Chancellor
9. PS to Registrar.

Assistant Registrar (Academic)
for Registrar

Courses of Reading
for

B.Sc. (Engg.) Metallurgy and Materials Engineering Program
(Semester System)
Revised for Session 2020 onwards

Department of Metallurgy and Materials Engineering

Faculty of Engineering & Technology
University of the Punjab, Lahore

Department of Metallurgy and Materials Engineering

Faculty of Engineering & Technology
University of the Punjab, Lahore

Revised Curricula/Syllabi of Degree Program

Program Title: B.Sc. (Engg.) Metallurgy & Materials Engineering
Department: Department of Metallurgy & Materials Engineering
Faculty: Faculty of Engineering & Technology

- **Department Vision**
  Department of Metallurgy and Materials Engineering (DMME) will be a leading and dynamic seat of learning for quality education, research, innovation, and entrepreneurship.

- **Department Mission**
  The mission of the DMME is to provide a conducive environment for academics and research and to produce groomed and professionally sound individuals equipped with adequate knowledge and practical skills through quality education in the field of Metallurgy and Materials Engineering to contribute effectively in industry and research sector for the betterment of society.

- **Introduction**
  During its more than five decades of history, department of metallurgy and materials engineering has always been committed to excellence in educating students, conducting research and contributing to the development of Metallurgical and Materials industry of Pakistan. The highly skilled engineers and scientists have been employed to the national industrial sector as well as the middle east, Europe, Australia and USA. The graduates of this department are playing a vital role in improving the deterrence of the country by serving at Atomic Energy Commission, NDC, AWC, and in other defence related projects. Currently, the DMME is offering B.Sc. (Engg.), MSc. (Engg.) and PhD Metallurgy and Materials Engineering programs. The department is equipped with latest state-of-the-art equipment related to materials processing and characterization. The level of qualification and skills of the faculty ranks itself among the best countrywide.

- **Program Objectives**
  The graduates of the Metallurgy and Materials Engineering program of DMME, University of the Punjab, Lahore are expected to be characterized by the following qualities after three to five years of their graduation:

  PEO1: Graduates are able to utilize their engineering knowledge and managerial skills to solve the challenging problems in industry and research sector.
  PEO2: Graduates are able to enhance their engineering knowledge through continuous professional and personal development by learning modern engineering tools, techniques and practicing their applications in the context of social and environmental challenges.

PEO3: Graduates are capable of contributing positively towards society through practicing professional ethical values and communication skills.

- **Faculty**

Degree	Area / Specialization	Total
PhD	1. **Prof. Dr. Mohsin Ali Raza** Materials Engineering (Composite Materials, Polymeric Materials, Nanomaterials, Energy Storage, Supercapacitors) 2. **Prof. Dr. Muhammad Kamran** Solidification Processes, Foundry Engineering, Welding Technology 3. **Prof. Dr. Tahir Ahmad** Powder Metallurgy 4. **Dr. Asma Salman** Thermal Barrier Coatings 5. **Dr. Muhammad Umar Manzoor** Thin Film, Composites, Polymers, Carbon Nanotubes 6. **Dr. Aqil Inam** Steel Manufacturing and Heat Treatment 7. **Dr. Muhammad Atif Makhdoom** Foundry Engineering, Electronic Materials, Solar Cell	07
MS	1. **Engr. Aamir Nadeem Malik** Iron and Steel manufacturing 2. **Engr. Nauman Alam Siddiqui** Mechanical Testing, Welding Technology 3. **Engr. Faraz Hussain** Corrosion Engineering, Biomaterials 4. **Engr. Fahad Riaz** Corrosion Engineering, Biomaterials 5. **Engr. Ameeq Farooq** Surface and Corrosion Engineering 6. **Engr. Sehrish Mukhtar** Biomaterials 7. **Engr. Muhammad Haseeb Hassan** Metallurgy & Materials Engineering, Occupational Health & Safety, Total Quality Management	08

	8. **Engr. Muhammad Ishtiaq** Physical Metallurgy, Heat Treatment and Phase Transformations	
Total		**15**

- **Admission and Eligibility Criteria**

Admissions to the B.Sc. (Engg.) Metallurgy and Materials Engineering at this department takes place once a year for fall semester. The following admission criteria are adopted:

- The applicant must have taken entry test.
- Applicant must be domiciled in Punjab.
- Applicant must have passed F.Sc. (Pre-engineering) or equivalent examination in defined time period with minimum 60% marks.
- The age limit for admission on F.Sc. basis is 24 years.
- 30% weightage is given to pre-admission entry test conducted by UET, Lahore.
- Percentage/CGPA: At least 60% marks (excluding Hafiz-e-Quran) either in Intermediate Examination on the basis of Aggregated Marks Percentage calculated as given below:

$$A = \left[\frac{(Marks\ obtained\ in\ F.Sc.\ or\ equivalent\ examination) + (Hafiz - e - Quran)^{*}}{1100}\right] \times 70$$

$$T = \left[\frac{Marks\ obtained\ in\ Entry\ Test}{400}\right] \times 30$$

Aggregated Marks Percentage = A + T

*20 marks for Hafiz-e-Quran, if applicable, will be included as shown above.

- **Student/Teacher Ratio**

Total number of students = 298
Total number of teachers = 15
298/15 = 19.8 **(Full time faculty)**

- **NOC from Professional Council**

The B.Sc. (Engg.) Metallurgy and Materials Engineering program is accredited by Pakistan Engineering Council. The accreditation history of the DMME in last decade is provided in following Table 1.

Table 1: Accreditation history of DMME.

Sr. No.	Accreditation Visit Date	Accredited Batch(s)
1	July 2015	2011
2	July 2015	2012
3	18-19 July 2017	2013
4	18-19 July 2017	2014
5	Change of Scope visit (May 31, 2018)	Approved w.e.f. Fall 2015
6	27-29 March, 2019	2015
6	27-29 March, 2019	2016

- **Award of Degree Requirement**

  Degree awarding criteria stating: **Completion of 133 credit hours.**
  CGPA percentage required to Qualify: **Minimum 2.0 CGPA for degree awarding**.
  Internship: **Supervised Internship of 4 to 6 weeks during the course of study.**

- **Research Thesis / Project /Internship**
  Mandatory as per PEC requirements, 4 – 6 weeks' internship in relevant industry during the course of study (no credit hours)
  Design Project Report Credit Hours = 06 (will be carried out in 7th and 8th semester)

Course Code Methodology:

- The three alphabets in a course indicate the discipline, for example, B.Sc. (Engg.) for Metallurgy and Materials Engineering.
- The first digit in the course code indicates the academic year during which the course if offered, for example, the first digit 2 in "MME 214 Engineering Mechanics" indicates that this course is offered during the 2nd academic year.
- The second digit in the course code indicates the semester of the academic year, for example, the second digit 1 in "MME 214 Engineering Mechanics" indicates that this course is offered during the 1st semester of the 2nd academic year.
- The Third digit in the course code indicates the serial number of the course amongst the courses being taught in a semester, for example, the third digit 4 in "MME 214 Engineering Mechanics" indicates that it is the fourth course being taught in the 1st semester of the 2nd academic year.
- NSC stands for Natural sciences, CSC stands for computer sciences, MEG stands for Mechanical Engineering, HUM stands for Humanities, MSC stands for Management sciences and MIN stands for Mining Engineering.

Courses of Reading for
B.Sc. (Engg.) Metallurgy & Materials Engineering

First Semester

Paper	Course Code	Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	HUM 111	Functional English	3	0	3
II	NSC 112	Applied Chemistry	3	1	4
III	NSC 113	Engineering Mathematics-I	3	0	3
IV	CSC 114	Computer Science and Information Technology	2	1	3
V	MME 115	Fundamentals of Metallurgy and Materials Engineering	3	0	3
VI	HUM 116	Islamic Studies/Ethics*	2	0	2
		Total	**16**	**2**	**18**

Second Semester

Paper	Course Code	Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	MME 121	Engineering Drawing	1	1	2
II	MME 122	Workshop practice	0	1	1
III	MIN 123	Mineral Processing	2	1	3
IV	NSC 124	Engineering Mathematics-II	**3**	0	3
V	NSC 125	Applied Physics	3	1	4
VI	HUM 126	Pakistan Studies	2	0	2
VII	HUM 127	The Holy Quran Translation	1	0	0
		Total	**12**	**4**	**15**

*Only for non-Muslim students in place of Islamic Studies.

Third Semester

Paper	Course Code	Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	HUM 211	Communication skills	2	0	2
II	MME 212	Physical Metallurgy	3	1	4
III	MME 213	Ceramics Science and Engineering	3	1	4
IV	MME 214	Engineering Mechanics	3	0	3
V	MSC 215	Industrial Safety and Environmental Management	3	0	3
VI	HUM 216	The Holy Quran Translation	1	0	0
		Total	**14**	**2**	**16**

Fourth Semester

Paper	Course Code	Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	MME 221	Mechanical behavior of Engineering Materials	3	1	4
II	MME 222	Polymer Science and Engineering	3	0	3
III	MME 223	Materials Thermodynamics and Kinetics	3	0	3
IV	MME 224	Foundry Engineering-1	2	1	3
V	CSC 225	Computer Aided Design	0	1	1
VI	CSC 226	MATLAB and Simulink	**0**	1	1
VII	HUM 227	Technical Writing	2	0	2
		Total	**13**	**4**	**17**

Fifth Semester

Paper	Course Code	Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	MME 311	Iron Manufacturing Technology	2	0	2
II	MME 312	Foundry Engineering-II	3	1	4
III	MME 313	Heat Treatment of Metals and Alloys	3	1	4
IV	MME 314	Transport Processes	3	0	3
V	MME 315	Metallurgical Manufacturing Processes	3	0	3
VI	HUM 316	Critical Thinking and Reasoning	2	0	2
VII	HUM 317	The Holy Quran Translation	1	0	0
		Total	**17**	**2**	**18**

Sixth Semester

Paper	Course Code	Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	MME 321	Corrosion Engineering	3	1	4
II	MME 322	Welding and Joining Processes	3	1	4
III	MME 323	Steel Manufacturing Processes	3	0	3
IV	MME 324	Composite Materials	2	0	2
V	MME 325	Polymeric and Composite Materials	0	1	1
VI	CSC 326	Computational Materials Science	2	0	2
VII	CSC 327	Computer Applications in Materials Engineering	0	1	1
		Total	**13**	**4**	**17**

Seventh Semester

Paper	Course Code		Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	MME 411		Tribology and Surface Engineering	3	1	4
II	MME 412		Materials Characterization	2	1	3
III	MME 413		Non-ferrous Metallurgy	3	0	3
IV	Elective-I	MME 414 A	Biomaterials	2	0	2
		MME 414B	Nanomaterials and Nanotechnology			
V	MSC 415		Industrial Quality Management	3	0	3
VI	MME 416		Design Project - I	0	3	3
			Total	**13**	**5**	**18**

Eighth Semester

Paper	Course Code		Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	MME 421		Powder Metallurgy	2	0	2
II	Elective-II	MME 422 A	Advanced Metallic Materials	2	0	2
		MME 422 B	Advanced Fabrication Processes			
III	MSC 422		Production and Operations Management	3	0	3
IV	MSC 423		Entrepreneurship	2	0	2
V	HUM 424		Industrial Psychology and Sociology	2	0	2
VI	MME 425		Design Project - II	0	3	3
VII	HUM 426		The Holy Quran Translation	1	0	0
			Total	**12**	**3**	**14**

Total Credit Hours of the Course = 133

FRAMEWORK AS PER HEC/PEC GUIDELINES FOR B.Sc. (Engg.) METALLURGY AND MATERIALS ENGINEERING

Non-Engineering Domain								% Area	% Overall
Knowledge Area	**Subject Area**	**Name of Course**	**Lec CH**	**Lab CH**	**CR**	**Total Courses**	**Total Credits**		
Humanities (HUM)	English	Communication Skills	2	0	2	3	7		
		Functional English	3	0	3				
		Technical Writing	2	0	2				
	Culture	Pakistan Studies	2	0	2	2	4		
		Islamic Studies/ Ethics	2	0	2				
	Social Sciences	Critical Thinking and Reasoning	2	0	2	2	4		
		Industrial Psychology and Sociology	2	0	2				
Management Sciences (MSC)		Industrial Safety and Environment Management	3	0	3	4	11		
		Industrial Quality Management	3	0	3				
		Production and Operations Management	3	0	3				
		Entrepreneurship	2	0	2				
Natural Sciences (NSC)	Physics	Applied Physics	3	1	4	1	4		
	Mathematics	Engg. Mathematics-I	3	0	3	2	6		
		Engg. Mathematics-II	3	0	3				
	Chemistry	Applied Chemistry	3	1	4	1	4		
SUB TOTAL						15	40	100	30

Engineering Domain								**% Area**	**% Overall**
Knowledge Area	**Subject Area**	**Name of Course**	**Lec CH**	**Lab CH**	**CR**	**Total Courses**	**Total Credits**		
Computing (CSC)	Fundamentals	Computer Science and Information Technology	2	1	3	4	7		
	Programming	MATLAB and Simulink	0	1	1				
	Design	Computational Materials Science	2	0	2				
		Computer Applications in Materials Engineering	0	1	1				
Engineering Foundation (EF)		Engineering Drawing	1	1	2	09	24		
		Workshop Practice	0	1	1				
		Fundamentals of Metallurgy and Materials Engineering	3	0	3				
		Mechanical Behavior of Engineering Materials	3	1	4				
		Physical Metallurgy	3	1	4				
		Materials Thermodynamics & Kinetics	3	0	3				
		Transport Processes	3	0	3				
		Engineering Mechanics	3	0	3				
		Computer Aided Design	0	1	1				
Major Based Core Breadth (MBCB)		Heat Treatment of Metals and Alloys	3	1	4	9	25		
		Steel Manufacturing Processes	3	0	3				
		Iron Manufacturing	2	0	2				
		Non-Ferrous Metallurgy	3	0	3				
		Ceramics Science and Engineering	3	1	4				
		Metallurgical Manufacturing Processes	3	0	3				
		Polymeric Science and Engineering	3	0	3				
		Composite Materials	2	0	2				
		Polymeric and Composite Materials	0	1	1				
Major Based Core Depth (MBCD)		*Elective Course-I (Biomaterials or Nanomaterials and Nanotechnology)	2	0	2	9	28		
		Welding and Joining Processes	3	1	4				
		Foundry Engineering-I	2	1	3				
		Corrosion Engineering	3	1	4				
		Materials Characterization	2	1	3				
		Surface Engineering & Tribology	3	1	4				
		Foundry Engineering-II	3	1	4				
		Powder Metallurgy	2	0	2				

		Elective-II (Advanced Fabrication Processes or Advanced Metallic Materials)	2	0	2				
Inter-disciplinary Engineering Breadth (IDEB)		Mineral Processing	2	1	3	1	3		
Senior Design Project		Design Project-1	0	3	3	2	6		
		Design Project-1	0	3	3				
Industrial Training			0	0	0	0	0	0	0
SUB TOTAL						34	93	100	70
GRAND TOTAL						49	133		100

Summary				
Domain	**Knowledge Area**	**Total Courses**	**Total Credits**	**% Overall**
Non-Engineering	Humanities	7	15	30
	Management Sciences	4	11	
	Natural Sciences	4	14	
	Sub Total	**15**	**40**	
Engineering	Computing	4	7	70
	Engineering Foundation	9	24	
	Major Based Core (Breadth)	9	25	
	Major Based Core (Depth)	9	28	
	Inter-Disciplinary Engineering Breath (Electives)	1	3	
	Design Project	2	6	
	Industrial Training	0	0	
	Sub Total	**34**	**93**	
Grand Total		**49**	**133**	**100**

Separate Course Outlines for each course

First Semester

1. HUM 111 Functional English

- **Title:** Functional English
- **Code Number:** HUM 111
- **Semester:** 1st
- **Credit Hours:** 3
- **Pre-requisites:** Basic knowledge of English Language
- **Learning Outcomes[1]:**

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

1. Communicate effectively in society and engineering community.
2. Develop technical documents with effective message.
3. Comprehend instructions effectively.

Course Outline

Unit-1: Grammar

1.1 Basics of Grammar
1.2 Parts of speech and use of articles
1.3 Sentence structure
1.4 Active and passive voice
1.5 Analysis of phrase
1.6 Clause and sentence structure
1.7 Transitive and intransitive verbs
1.8 Punctuation and spelling
1.9 Vocabulary building exercises
1.10 Synonyms, antonyms and homonyms
1.11 One-word substitution**,** Idiomatic sentences
1.12 Correction of errors.

Unit-2: Comprehension: Answers to questions on a given text.
Unit-3: Discussion: General topics and everyday conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students).
Unit-4: Listening: To be improved by showing documentaries/films carefully selected by subject teachers. Listening and Speaking: Oral communication Skills Development.
Unit-5: Translation skills: Urdu to English
Unit-6: Presentation skills: Introduction.
Unit-7: Study Skills: Advanced reading skills using (e.g. text related to such issues as ILO laws environment / resettlement / rehabilitation etc.)

[1] All learning outcomes of relevant subject mentioned in this document are not fixed and subject to change depending upon feedback of students and annual assessment by DQEC team.

Unit-8: Writing Skills

8.1 Precis writing
8.2 Paragraph Writing
8.3 Controlled & guided writing
8.4 Essay writing
8.5 Writing letters and memo
8.6 Solving IELTS type papers

Recommended Books

1. G. Woods, "English grammar for dummies", John Wiley & Sons (2017)
2. G. Nelson, S. Greenbaum, "An introduction to English grammar", Routledge (2017)
3. S. Bailey, "Academic writing: A handbook for international students", Routledge (2017)
4. P. Collins, C. Hollo, "English grammar: An introduction", Macmillan International Higher Education (2016).
5. A. J. Thomson and A. V. Martinet, "Practical English Grammar" Oxford University Press, 3rd Edition (1997).
6. P.C. Wren and H. Martin, "High School Grammar and Composition" Blackie EIT Books (1995).
7. S. Brinand and F. Grellet, "Writing. Intermediate" Oxford Supplementary Skills,4th Edition (1993).

Teaching-learning Strategies

The teaching and learning strategy has been designed on the understanding of concepts and the ability to critically analyze and apply the learned content through lectures, discussion, activities, case studies using computer, multi-media and writing board instructional aids.

Assignments- Types and Number with calendar

Assignments / Quizzes (minimum 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

II NSC 112 Applied Chemistry

- **Title:** Applied Chemistry
- **Code Number:** NS 112
- **Semester:** Ist
- **Credit Hours:** 4(3,1)
- **Theory Credit Hours:** 3
- **Lab Credit Hours:** 1
- **Lab Contact Hours:** 3
- **Pre-requisites:** Basic knowledge of High School Chemistry
- **Learning Outcomes**

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

1. Explain basic concept of chemical reactions, their kinetics and governing laws.
2. Comprehend basic knowledge of organic and analytical chemistry in metallurgy and materials engineering.
3. Apply stoichiometric calculations to metallurgy related problems.

Course Outline

Unit-1: Introduction

1.1. Classification of elements
1.2. Periodic table and electronic configuration
1.3. Energy levels and quantum degeneracy
1.4. Theories of chemical bonding (Molecular orbital theory, Valance band theory)
1.5. Anti bonding
1.6. Kinetic theory of gases

Unit-2: Equilibrium and Kinetics

2.1 Basic laws (Roult's law, Henry's law, Sievert's law)
2.2 Chemical equilibrium (Homogeneous and heterogeneous equilibrium)
2.3 Chemical kinetics

Unit-3: Heat and Energy

3.1 Forms of energy (Static and dynamic)
3.2 Dynamic form or energy interactions (Work and heat transfer)
3.3 Energy transfer by Heat and by Work
3.4 Type of energy (Macroscopic and Microscopic)
3.5 Internal energy (Latent energy, Chemical energy, Nuclear energy)
3.6 Heat transfer Mechanism (Conduction, Convection and Radiation)

Unit-4: Electro-chemistry

4.1 Laws of Electrolysis
4.2 Basic working principle of fuel cells, batteries, etc.

Unit-5: Properties of Solution & Liquids

5.1 Surface Tension
5.2 Viscosity, Osmosis, Osmotic Pressure, pH-Buffer Solution
5.3 Basic concepts of Colloidal Chemistry

Unit-6: Organic chemistry

6.1 Nature and sources of compounds

6.2 Chemistry of hydrocarbons
6.3 Cracking, Reforming, Octane number

Unit-7: Fuels

7.1 Types of fuels
7.2 Classification of fossil fuels and their applications
7.3 Concept of Fire point and Flash point of fuels

Unit-8: Environmental pollution

8.1 Introduction
8.2 Main sources and effects

Unit-9: Analytical chemistry

9.1 Introduction to qualitative and quantitative analysis of ferrous and non-ferrous metals
9.2 Introduction to analytical instruments
9.3 Fundamental and derived units, Dimensional Analysis
9.4 Presentation and Correlation of Metallurgical Data
9.5 Composition Relationships
9.6 Stoichiometric Calculations of Metallurgical Reactions
9.7 Excess Air, Flue Gas Analysis
9.8 P-V-T Relations for Gases
9.9 Material Balances in Metallurgical Processes.

Lab Outline: Practicals pertinent to above mentioned course outline.

Recommended Books

1. D.E Lewis, "Advanced Organic Chemistry", Oxford University Press (2015).
2. A. Bahl, "Advanced Organic Chemistry", S. Chand Company (2010).
3. E. A. Parnell, "Applied Chemistry", D. Appleton & Co., (2007).
4. Butts, "Metallurgical Problems", Johnston Press, (2007).
5. T. E. Brown, "Chemistry: The Central Science", Prentice Hall, (2005).
6. D. M. Himmelblau, J. B. Riggs, "Basic Principles and Calculations in Chemical Engineering", Prentice Hall, (2003).
7. H. D. Gasser, "Applied Chemistry", Springer, (2002).
8. C. Davies, "Calculations in Furnace Technology", Elsevier, (1970).

Teaching-learning Strategies

The teaching and learning strategy has been designed on the understanding of concepts and the ability to critically analyze and apply the learned content through lectures, discussion, activities, case studies using computer, multi-media and writing board instructional aids.

Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation (minimum 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

III NSC 113 Engineering Mathematics-I

- **Title:** Engineering Mathematics-I
- **Code Number:** NS 113
- **Semester:** 1st
- **Credit Hours:** 3
- **Pre-requisites:** Basic knowledge of High School Mathematics
- **Learning Outcomes**

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

1. Formulate derivatives and anti-derivatives of different functions and apply the techniques of integration to solve engineering problems.
2. Apply the properties of vector quantities commonly found in engineering applications.
3. Transform raw data into useful statistics to compute central tendencies and dispersions.

Course Outline

Unit-1: Differential Calculus

1.1 Introduction and motivations
1.2 A review of limits, continuity and differentiation
1.3 Higher Derivatives
1.4 Total differential, The Product and Quotient Rules
1.5 Composite functions and chain rule
1.6 Implicit differentiation

Unit-2: Differential Equations

2.1 Solution of first order linear and special types of second and higher order differential equations used in engineering problems
2.2 Applications of Derivatives
2.3 Homogeneous and Non-homogeneous linear differential equations with constant coefficients
2.4 Linear equations with variable coefficients
2.5 Tangent and Normal
2.6 Curvature and Radius of Curvature using Derivative

2.7 Increasing and decreasing functions
2.8 Maxima and minima of a function of one & two variables**,** Asymptotes and Concavity

Unit-3: Integral Calculus

3.1 Different Techniques of Integration
3.2 Definite integral and its properties
3.3 Fundamental theorem of Integral Calculus
3.4 Applications of Integration
3.5 Double integration
3.6 Applications in finding areas (e,g, area of cross section, area of surface of revolution), volumes (volume of a solid, a solid of revolution, cylindrical shells), centroids, center of pressure. Arc length
3.7 Fluid Pressure and Force
3.8 Use of Integration techniques in Materials Engineering

Unit-4: Vector Analysis

4.1 Review of vector algebra
4.2 Dot and Cross products of vectors with physical interpretation
4.3 Scalar and vector point functions
4.4 Scalar triple product
4.5 Vector triple product
4.6 Physical interpretation with application
4.7 Gradient of a function; Divergence, curl and their physical interpretations
4.8 Gauss's and Green's Theorems**,** Orthogonal curvilinear Co-ordinates

Unit-5: Statistics

5.1 Representation of Data, Graph and it types
5.2 Measure of Central Tendency, e.g. Mean, Mode and Median, Measure of Dispersion, e.g. Mean Deviation, Standard Deviation and Moments
5.3 Basic Probability: Laws of Probability with application to engineering, Probability distributions
5.4 Binomial distribution
5.5 Normal and Uniform distribution
5.6 Methods of Least squares and curve fitting
5.7 Regression analysis and sampling distribution

Recommended Books

1. D.G. Zill, "Advanced Engineering Mathematics" 6th Ed. Jones and Barlett Learning (2016).
2. B.D. Anton, "Calculus" 10th Edition, Wiley (2015).
3. E. Kreyszig et al., "Advanced Engineering Mathematics" 10th Ed. Wiley (2011).
4. G.B. Thomas et al., "Calculus and Analytical Geometry" 9th Ed. Addison Wesley (1998).

Teaching-learning Strategies
The teaching and learning strategy has been designed on the understanding of concepts and the ability to critically analyze and apply the learned content through lectures, discussion, activities, case studies using computer, multi-media and writing board instructional aids.

Assignments- Types and Number with calendar
Assignments / Quizzes or Complex Engineering Problem (minimum 2) will be submitted before the written exam of the final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

IV CSC 114 Computer Science and Information Technology

- **Title:** Computer Science and Information Technology
- **Code Number:** CS 114
- **Semester:** 1st
- **Credit Hours:** 3 (2,1)
- **Theory Credit Hours:** 2
- **Lab Credit Hours:** 1
- **Lab Contact Hours:** 3
- **Pre-requisites:** Basic knowledge of science and Mathematics
- **Learning outcomes**

Upon successful completion of the course, the students will be able:

1. Comprehend the basics of computer hardware and internet.
2. Apply tools of MS office to develop formal reports and datasheets.

Course Outline

Unit-1: Introduction to Computers

1.1 History and Classification
1.2 Basic components: CPU, Memory Peripheral devices, structures and their addressing, I/O devices and data storage devices
1.3 Data storage and retrieval
1.4 Motherboard and devices

1.5 Physical and logical storage
1.6 Number systems
1.7 Logic gates
1.8 Data organization
1.9 File storage
1.10 Application software
1.11 Operating systems, General features of Microsoft Windows operating
1.12 Other operating systems (Linux, Unix, etc.)
1.13 Mainframes and Microcomputers
1.14 Supercomputers
1.15 Social impact of computer age

Unit-2: MS Word

2.1 Document creation, editing & formatting (use of styles, templates, tables, equation, spelling and grammar checking, page numbering and auto table-of-contents etc.).

Unit-3: MS Excel

3.1 Data types & their entry
3.2 Editing and formatting the spread sheet
3.3 Rows, columns & cells creation, deletion & formatting
3.4 Various common formula and their use
3.5 Use of relative and absolute addresses
3.6 Paste and paste-special features
3.7 Use of data analyses tools and built-in functions
3.8 Arithmetic operations**,** Use of charting tools.

Unit-4: MS Visio

4.1 Creating projects and Flow diagrams.

Unit-5: Information Technology

5.1 Internet
5.2 Networking
5.3 7 layer network model
5.4 Servers and clients
5.5 Network topology and the basic parts of a URL
5.6 Proxy software
5.7 Basics of the terminal or command line
5.8 System file structure and hierarchy, Basic terminal commands
5.9 How to use the command line to perform basic operations such as navigating a file directory and performing operations on files

Lab Outline: Practical pertaining to above mentioned course work.

Recommended Books

1. O. Leary "Computing Essentials 2019", McGraw-Hills, 27th Edition (2019).
2. G. H. MacEwen, "Introduction to Computer Systems", McGraw-Hill (2007).
3. J. A. Aseltine, "Introduction to Computer Systems", Wiley, (2007).
4. A. J. Herbert, R. M. Needham, "Computer Systems", Springer (2004).

Teaching-learning Strategies

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Assignments- Types and Number with calendar
At least 2 Assignments / Quizzes / Presentation / Open Ended Lab will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

V MME 115 Fundamentals of Metallurgy and Materials Engineering

- **Title:** Fundamentals of Metallurgy and Materials Engineering
- **Code Number:** MME 115
- **Semester:** 1st
- **Credit Hours:** 3 (3,0)
- **Theory Credit Hours:** 3
- **Pre-requisites:** Basic knowledge of physics and chemistry
- **Learning Outcomes**

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

1. Comprehend basic types of metallurgy and materials and their applications.
2. Comprehend basics of crystallography

Course Outline

Unit-1: Introduction

1.1 Objectives & importance of Metallurgy and Materials Engineering
1.2 Scope of Metallurgy and Materials Engineering in Pakistan
1.3 Metallurgical Engineer's Jobs

Unit-2: Classification

2.1 Branches of Metallurgy
2.2 Classification, application & characteristics of engineering materials

2.3 Non-metals
2.4 Raw materials for alloys

Unit-3: Materials Engineering

3.1 Materials Science and Engineering
3.2 Material Selection criteria
3.3 An introduction to new breeds of engineering materials e.g., nano-, shape memory-, smart-, bio-, energy-, electrical-, magnetic- and optical materials. Materials for aerospace and transportation industries

Unit-4: Materials Science

4.1 Atomic arrangement of various materials
4.2 Types of Bonding
4.3 Principal Metallic Crystal Structures
4.4 Crystal system
4.5 Density Computations
4.6 Polymorphism and Allotropy
4.7 Point Coordinates
4.9 Crystallographic Directions
4.10 Crystallographic Planes
4.11 Linear and Planar Densities
4.12 Close-Packed Crystal Structures
4.4 Atom Position in Cubic Unit Cells
4.5 Unit Cell Calculations
4.6 Atomic packing factor
4.7 Comparison of FCC, HCP and BCC Crystal Structures
4.8 Behavior and properties of engineering materials
4.10 Crystal structure analysis; effect of bond type on structure and properties i.e. density, stability, melting point, stiffness, and electrical properties.

Recommended Books

1. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley and Sons, 10th Edition (2018).
2. W.F. Smith, "Principles of Materials Science Engineering", McGraw Hill, (2005).
3. S. H. Avner, "Introduction to Physical Metallurgy", Tata McGraw-Hill, Inc., (1997).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

At least 2 Assignments / Quizzes / Presentation will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

VI HS 116 Islamic Studies/Ethics

- **Title:** Islamic studies/Ethics
- **Code Number:** HS 116
- **Semester:** 1st
- **Credit Hours:** 2
- **Pre-requisites:** Basic knowledge of High school Islamic studies/Ethics.
- **Learning Outcomes**

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

1. Describe living with peace, respect and free from stress.
2. Respect the doings and cultures of other religions.
3. Understand the Halal and Haram and to find the ways to eliminate haram things in their lives.
4. Practice the life as per commands of Quran and Sunnah.

Course Outline

Unit-1: Introduction to Quranic studies

1.1 Basic concepts of Quran
1.2 History of Quran
1.3 Uloom-ul-Quran
1.4 Study of Selected Text Of Holy Quran
1.4.1 Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
1.4.2 Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
1.4.3 Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
1.4.4 Verses of Surah al-Furqan Related to Social Ethics (Verse No. 63-77)
1.4.5 Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)
1.4.6 Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No. 6, 21, 40, 56, 57, 58.)
1.4.7 Verses of Surah Al-Hashar (18, 19, 20) Related to thinking, Day of Judgment
1.4.8 Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No-1, 14)
1.5 Seerat of Holy Prophet (S.A.W) I
1.5.1 Life of Muhammad Bin Abdullah (Before Prophet Hood)

1.5.2 Life of Holy Prophet (S.A.W) in Makkah
1.5.3 Important lessons derived from the life of Holy Prophet (SAW) in Makkah
1.5.4 Life of Holy Prophet (SAW) in Madina
1.5.5 Important events of life of Holy Prophet (SAW) in Madina
1.5.6 Important lessons derived from the life of Holy Prophet (SAW) in Madina

Unit-2: Sunnah and Hadith

2.1 Basic concepts of Hadith History of Hadith
2.2 Kinds of Hadith Uloom–ul-Hadith Sunnah & Hadith
2.3 Legal position of Sunnah
2.4 Selected Study from Text of Hadith

Unit-3: Introduction to Islamic Law & Jurisprudence

3.1 Basic concepts of Islamic law & jurisprudence
3.2 History & importance of Islamic law & jurisprudence Sources of Islamic law & jurisprudence
3.3 Nature of differences in Islamic law Islam and sectarianism

Unit-4: Islamic Culture & Civilization

4.1 Basic concepts of Islamic culture & civilization
4.2 Historical development of Islamic culture & civilization Characteristics of Islamic culture & civilization
4.3 Islamic culture & civilization and contemporary issues

Unit-5: Islam & Science

5.1 Basic concepts of Islam & science
5.2 Contributions of Muslims in the development of science Quranic & science
5.3 Islamic Economic System

Unit-6: Basic concepts of Islamic economic system

6.1 Means of distribution of wealth in Islamic economics Islamic concept of riba
6.2 Islamic ways of trade & commerce

Unit-7: Political System of Islam

7.1 Basic concepts of Islamic political system Islamic concept of sovereignty
7.2 Basic institutions of government in Islam

Unit-8: Islamic History

8.1 Period of Khlaft-e-Rashida Period of Ummayyads
8.2 Period of Abbasids

Unit-9: Social System of Islam

9.1 Basic concepts of social system of Islam Elements of family
9.2 Ethical values of Islam

Recommended Books

1. Akhtar H M, "Islamiat", Allied Book Sons (2012).
2. Al-Bukhari—Vol, S. 7, Book 71, Hadith 648. Sunnah. com—Sayings and teachings of Prophet Muhammad
3. M. Hamidullah, "The Muslim conduct of state", The Other Press.
4. A. Maududi "Towards Understanding Islam, Updated for a Modern World", Idara Tarjuman ul Quran.
5. M. Hamidullah, "Introduction to Islam" CSS Point.

Teaching-learning Strategies
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Assignments- Types and Number with calendar
At least 2 Assignments / Quizzes / Presentations will be submitted before the written exam of final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

Second Semester

I MME 121 Engineering Drawing

- **Title:** Engineering Drawing
- **Code Number:** MME 121
- **Semester:** 2nd
- **Credit Hours:** 2(1,1)
- **Theory Credit Hour:** 1 per week
- **Lab Credit Hour:** 1 per week
- **Lab Contact Hours:** 3 per week
- **Pre-requisites:** Basic knowledge of Mathematics
- **Learning Outcomes**

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

1. Comprehend the knowledge of lines and shapes.
2. Use their knowledge to draw engineering objects in different angle of projections.

Course Outline

Unit-1: Introduction to engineering drawing

1.1 Graphic language
1.2 Ways to create engineering drawing
1.3 Use of instruments
1.4 Elements of a drawing

Unit-2: Drawing Standards

2.1 Introduction to codes and standards
2.2 Drawing scales
2.3 Planning of drawing sheets, Lettering, word & sentence composition
2.4 Basics of different lines in engineering drawing

Unit-3: Using Drawing Tools

3.1 Preparation of tools
3.2 Functions & usage of tools, Applied Geometry

Unit-4: Orthographic Projection

4.1 Projection Theory
4.2 Multiview drawing
4.3 Line convention
4.4 Orthographic Writing**:** Overall steps, Criteria of view selection, Alignment of views, Basic dimensioning, auxiliary views

Unit-5: Pictorial Sketching

5.1 Free hand sketching technique
5.2 Pictorial projections (Axonometric, Oblique)
5.3 Isometric projection
5.4 Isometric sketch
5.5 Oblique sketch

Unit-6: Dimensioning

6.1 Introduction
6.2 Dimensioning components and their recommended practices
6.3 Dimensioning of an object's features, Placement of dimension

Unit-7: Section Views

7.1 Introduction
7.2 Basic components
7.3 Kinds of section
7.4 Dimensioning of section views.

Lab Outline: Practical pertaining to course content mentioned above.

Recommended Books

1. J. D. Bethune, "Engineering Graphics with AutoCAD 2020", Adobe Press (2019).
2. H. L. Thompson, "Engineering Drawing Practice and Theory and Practice", International Textbook Company (2007).
3. T. E. French, "Engineering Drawing", McGraw-Hill, (2006).
4. C. W. Weick, "Elementary Mechanical Drawing", McGraw-Hill (2006).
5. A.C Parkinson, "A First Year Engineering Drawing", Pitman (1946).

Teaching-learning Strategies

The teaching and learning strategy has been designed on the understanding of concepts and the ability to critically analyze and apply the learned content through lectures, discussion, activities, case studies using computer, multi-media and writing board instructional aids.

Assignments- Types and Number with calendar

Assignments / Quizzes / Complex Engineering Problems will be submitted before the written exam of the final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

II MME 122 Workshop Practice

- **Title:** Workshop Practice
- **Code Number:** MME 122
- **Semester:** 2nd
- **Credit Hours:** 1 per week
- **Lab Contact Hours:** 3 h per week
- **Pre-requisites:** -
- **Learning Outcomes**

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

1. Comprehend functionality of various hand and machine tools.
2. Practice various hand and machine tools to fabricate an engineering object.
3. Practice health & safety measures in working environment.

Lab Course Outline

Unit-1: Introduction to workshop and layout planning

1.1 Workshop tool
1.2 Bench Fitting
1.3 Description, proper use and maintenance of the fitting tools
1.4 Use and care of measuring instruments
1.5 Preparation of some specific job

Unit-2: Health and Safety

2.1 Identification of various types of hazards in workshops
2.2 Introduction to personal protective equipment (PPE) & their usage in working environment.

Unit-3: Machining

3.1 Parts of lathe machine
3.2 Various tools and their uses for different machining operations
3.3 Introduction to milling, planning and CNC machines
3.4 Preparation of some specific job using these machines

Unit-4: Wood working

4.1 Use and care of wood working tools, clamps, planes, files, etc.
4.2 screwing, joining and doweling
4.3 Preparation of some specific job

Unit-5: Electrical fitting

5.1 Types of electrical fitting and their use
5.2 Power cables and their selection
5.3 Joining of electrical cables, etc.,
5.4 Preparation of some specific job

Unit-6: Metal joining processes

6.1 Welding, brazing, soldering and riveting etc.

Unit-7 Flow meters, thermocouples and pressure gauges

Recommended Books

1. H.S. Bawa, "Workshop Practice", McGraw Hill Publications (2017).
2. K. C. Johns, "Mechanical Workshop Practice", PHI Learning Pvt. Ltd., (2010).
3. A. P. Longmans, "Workshop Practice", Green & Co. (2007).
4. A. P. Longmans, "Machine Tools and Workshop Practice" Green & Co. (2007).
5. R. F. Yates, "Model Making Including Workshop Practice", The Norman W. Henley Publishing Co., (2007).
6. H. W. Baker, "Modern Workshop Technology", Cleaver- Hume Press (2006).
7. S.K. Garg, "Workshop Technology", Laxmi Publications (2005).

Teaching-learning Strategies

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III NSC 123 Applied Physics

- **Title:** Applied Physics
- **Code Number:** NSC 123
- **Semester:** 1st
- **Credit Hours:** 4(3,1)
- **Theory Credit Hours:** 3
- **Lab Credit Hour:** 1
- **Lab Contact Hours:** 3 per week
- **Pre-requisites:** Basic knowledge of High School Physics
- **Learning Outcomes**

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

1. Comprehend the fundamental physical laws with their applications.
2. Explain particle duality with associated physical laws and its behavior under various circumstances.
3. Explain electricity and magnetism on the basis of their fundamental physical laws.

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

Course Outline

Unit-1: Classical Physics:

1.1 Static equilibrium and dynamics
1.2 Rotating reference frames
1.3 Scattering in central force fields
1.4 Trajectories of near-Earth meteorites
1.5 Thermodynamics of interacting systems, including the first and second laws of thermodynamics
1.6 Concepts of equilibrium, enthalpy and entropy, and applications

Unit-2: Quantum & Nuclear Physics

2.1 Einstein's Photoelectric Effect Law
2.2 Planck's Black-body Radiation Law
2.3 Quantum Theory of matter & radiation
2.4 Dual nature of particles
2.5 Schrödinger wave equation and its application
2.6 Concept of quantum well, quantum confinement & quantum dots
2.7 Plasmonic effect, Concept of Phonons
2.8 Concept of Brillouin zone
2.9 Work function
2.10 Physical significance of Quantum Mechanics
2.11 Modern Nuclear Physics in Engineering Domain
2.12 Medical uses of Nuclear Radiation
2.13 Fission and Fusion
2.14 Energy release
2.15 Nuclear Reactors

Unit-3: Physics of Electricity & Magnetism

3.1 Introduction to electromagnetic theory
3.2 Electrostatics
3.3 Magnetostatics
3.4 Electromagnetic Theory
3.5 Maxwell Equations
3.6 Gauss' Law for electricity
3.7 Gauss' Law for Magnetism
3.8 Faraday's Law
3.9 Ampere-Maxwell Law
3.10 Physical properties of materials; thermal, electrical, magnetic and optical properties
3.11 Magnetic domains
3.12 Concept of direct-indirect band gaps and band bending phenomenon in semi-conductors
3.13 Deviation from Ohm's Law with onset of Space Charge limiting current
3.14 Different modes of charge transport in disordered media under different circumstances

Unit-4: Solid State Physics in Materials Engineering

4.1 Solid State and Solid-State Physics
4.2 Types of Solids and Crystal Structure
4.3 Elastic constants, Lattice vibrations and phonons
4.4 Free Electron Theory of matters

4.5 Band Theory of Solids
4.6 Transport Properties
4.7 Semiconductors
4.8 Superconductors
4.9 Dielectrics
4.10 Optical Process in insulators

Unit-5: Electrical Machines

5.1 Introduction to electrical machines
5.2 A.C. Motors, Singles and Three phase system
5.3 Linear motors
5.4 DC motors
5.5 Solenoid and its applications
5.6 Kirchhoff's rule
5.7 Power factor calculations.
5.8 Micro-electromechanical systems

Unit-6: Nanomaterials and Nanotechnology

6.1 Why does size matters in crystals:
6.2 Nanotechnology in nature
6.3 Nanomaterials and Physical properties
6.4 Nanophysics in materials engineering

Lab Outline: Practical activities pertaining to the course outlined above.

Recommended Books

1. D. Ewen and N. Schurter, "Applied Physics" Prentice Hall, Ed. 11th Edition (2017).
2. D. Halliday and R. Resnik, "Fundamentals of Physics", Willey (2010).
3. J. D. Cutnel, "Physics" Wiley; 8th Edition (2009).
4. M.A. Wahab, "Solid-State Physics: Structure and Properties of Materials", Narosa Publishing House, New Delhi (2005).
5. A. Beiser, "Applied Physics", McGraw-Hill, 4th Editon (2004).
6. C. Douglas, Giancoli, "Physics Principles and Applications", Pearson Education (2004)
7. A. Beiser, "Applied Physics", McGraw-Hill (2004).
8. S. Gibilisco, "Applied Physics", McGraw-Hill, (2002).
9. S. Gibilisco, "Applied Physics", McGraw-Hill (2002).
10. C. Kittle, "Introduction to Solid State Physics", Wiley (2000).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

IV MIN 124 Mineral Processing

- **Title:** Mineral Processing
- **Code Number:** MIN 124
- **Semester:** 2nd
- **Credit Hours:** 3(2,1)
- **Theory Credit Hour:** 2 per week
- **Lab Credit Hours:** 1 per week
- **Lab Contact Hour:** 3 per week
- **Pre-requisites:** Fundamentals of Metallurgy and Materials Engineering and Applied physics
- **Learning Outcomes**

  Upon successful completion of the course, the students will be able to
  1. Comprehend an overview of major classes of mineral processing equipment, their typical applications, and the types of projects in which they are used.
  2. Describe principles and operations involved in various concentration processes

Course Outline

Unit-1: Mineral deposits in Pakistan
Unit-2: Introduction to mineral properties utilized in separation of ore from gangue
Unit-3: Comminution

3.1 Theory of crushing
3.2 Operation and application of jaw-, gyratory-, cone-, roll, gravity stamp- and special crushers.
3.3 Theory and application of liberation techniques
3.4 Theory and attributes of comminution and use of ball, rod and tube mills

Unit-4: Separation and Concentration

4.1 Separation and concentration techniques
4.2 Sizing and sorting
4.3 Screening and classification
4.4 Gravity separation
4.5 Dense medium separation

4.6 Magnetic and electrical separation
4.7 Dewatering
4.8 Froth flotation
4.9 Practical processes coal washing, minerals sands, iron ore and non-ferrous ore concentration
4.10 Recovery economics
4.11 Principles of jigging
4.12 Hydraulic and pneumatic jigs
4.13 Flowing film concentration and tabling
4.14 Miscellaneous processes including leaching and separation
4.15 Separation of solids from fluids by thickening process
4.16 Filtration, dust elimination and drying
4.17 Theory and techniques of concentrates
4.18 Palletizing, nodulizing and briquetting
4.19 Flow sheets and circuit diagrams of physical separation processes in various industries, including minerals, coals, iron ore, etc,
4.20 Disposal technologies and pollution control

Lab Outline: Practical pertaining to above mentioned course contents.

Recommended Books

1. Barry A. Wills, "Wills' Mineral Processing Technology", Butterworth-Heineman 8th Edition (2015).
2. T. Rosenqvist, "Principles of Extractive Metallurgy", Tapir Academic Press, (2004).
3. M. C. Fuerstenau and N. H. Kenneth, "Principles of Mineral Processing", Society for Mining Metallurgy & Exploration (2003).
4. J. Newton, "Extractive Metallurgy", John Wiley & Sons Inc (1959).

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Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation / Open Ended Lab (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

V HUM 125 Pakistan Studies

- **Title: Pakistan Studies**
- **Code Number:** HUM 125
- **Semester:** 2nd
- **Credit hours:** 2 per week
- **Pre-requisites course requirements/ skills:** Intermediate Level
- **Learning Outcomes:**
  Upon successful completion of the course, the students will be able to
  1. Comprehend the ideological and historical struggle in the creation of Pakistan.
  2. Analyze the importance of geo-strategic location and its impact on Pakistani society and foreign policy.

Course Outline

Unit-I: Historical Perspective

1.1 Ideological rationale with special reference to Sir Syed Ahmed Khan
  1.1.1 Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah
1.2 Factors leading to Muslim separatism
  1.2.1 People and Land: Indus civilization
1.3 Muslim advent, location and Geo-physical features
1.4 Government and Politics in Pakistan
1.5 Political and constitutional phases (1947-58, 1958-71,1971-77, 1977-88, 1988-99,1999 onward)

Unit-II: Contemporary Pakistan

2.1 Economic institutions and issues
2.2 Society and social structure
2.3 Ethnicity
2.4 Foreign policy of Pakistan and challenges
2.5 Futuristic outlook of Pakistan

Recommended Books

1. A. Sattar, "Pakistan's foreign policy", 1947-2016: A concise history. Oxford University Press (2017).
2. A. Lieven, "Pakistan: A hard country" Public Affairs (2012).
3. A. Jalal, "The Oxford Companion to Pakistani History", Oxford University Press (2012).
4. S.P. Cohen, "The future of Pakistan. Brookings Institution" Press. (2011)
5. A.S. Zaidi, "Issue in Pakistan's Economy", Karachi Oxford University Press (2000)
6. S.M. Amin, "Pakistan's foreign policy: a reappraisal", Oxford Pakistan Paperbacks.

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation will be submitted before the written exam of the final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

VI NSC 125 Engineering Mathematics-II

- **Title:** Engineering Mathematics-II
- **Code Number:** NSC 126
- **Semester:** 2nd
- **Credit Hours:** 3 per week
- **Pre-requisites course requirements/ skills:** Engineering Mathematics-I
- **Learning Outcomes:**

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

1. Apply the properties matrix algebra commonly found in engineering applications.
2. Solve differential equations using Fourier series and Laplace transformation with their applications.
3. Construct mathematical models using PDEs to solve engineering problems.

Course Outline

Unit-1: Linear Algebra

1.1 Matrix Algebra
1.2 Introduction to Systems of Linear Equations and their solutions
1.3 Direct and Indirect Methods
1.4 Inevitability
1.5 Eigen values and eigenvectors of Matrices
1.6 Applications to flow models

Unit-2: Partial Differential Equations

2.1 Formation of partial differential equations. & their solutions
2.2 Classifications of partial differential equations
2.3 Treating as ordinary differential equations
2.4 Separation of variables
2.5 Some standard partial differential equations, Heat, Wave, Laplace Equations (one, two and three dimensions)
2.6 Modelling in engineering

Unit-3: Laplace Transform

3.1 Laplace transform of elementary functions
3.2 Laplace transform theorems
3.3 Inverse Laplace transform
3.4 Inverse Laplace transform theorems
3.5 Convolution**,** Laplace transform with derivatives and integrals
3.6 Solution of Differential Equations with the help of Laplace Transforms, Application of the Laplace transform

Unit-4: Fourier Series

4.1 Basic concepts of Fourier series
4.2 Periodic functions, periodic extensions
4.3 Fourier Series of Periodic Functions with Period 2Π
4.4 Fourier Series of Periodic Functions with Period 2 L
4.5 Fourier Series of Even and Odd Functions
4.6 Half Range Fourier Sine and Cosine
4.7 Solutions of PDEs using Fourier series
4.8 Finite Element Method
4.9 Finite Differential method and their application problems in engineering.

Recommended Books

1. W.E. Boyce, R.C Diprima "Elementary Differential Equations and Boundary Value Problems" 11th Edition, Wiley (2017).
2. H. Anton, "Elementary Linear Algebra", Wiley & Son, 11th Edition (2011).
3. E. Kreyszig, H. Kreyszig, et.al "Advanced Engineering Mathematics", Wiley, 10th Edition (2011).
4. M.R. Spiegel, "Vector Analysis", McGraw Hill, 2nd Edition (2009).

Teaching-learning Strategies
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Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

VII HUM 127 The Holy Quran Translation

- **Title:** The Holy Quran Translation/Ethics
- **Code Number:** HUM 127
- **Semester:** 2nd
- **Credit Hour:** 1 per week
- **Pre-requisites course requirements/ skills:** -
- **Learning Outcomes:**

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

1. Understand the translation and explanation of the Holy Quran
2. Demonstrate and practice the way of life in the light of teachings of Holy Quran

Course Outline

The students will learn Holy Quran with translation in this module. The course outline will be as approved by Academic Council of University of the Punjab.

Third Semester

I HUM 211 Communication Skills

- **Title:** Communication Skills
- **Code Number:** HUM 211
- **Semester:** 3rd
- **Credit hours:** 2 per week
- **Pre-requisites course:** English
- **Learning Outcomes:**

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

1. Identify barriers to communication and ways to overcome them.
2. Develop their non-verbal and para-verbal communication skills.
3. Communicate thoughts and ideas in a coherent way.
4. Design and giving strong, persuasive presentations.
5. Write business messages and e-mails effectively.
6. Write effective applications and letters.
7. Prepare their resume.

Course Outline

Unit-1: Communication Modes

1.1 Types of communication
1.2 Importance of effective communication
1.3 7 Cs of Effective Communication
1.4 The process and principles of communication
1.5 Planning organizing
1.6 Editing before communication
1.7 Persuasive communication
1.8 assertive communication skills
1.9 Professionalism in communication
1.10 Effective workplace communication scenario,

Unit-2: Interpersonal communications

2.1 Interpersonal communications and non-written communication for engineers
2.2 Influences on communication for engineers
2.3 Social and intercultural communication

Unit-3: Developing Effective Presentations

Unit-4: Oral Communication

Unit-5: Written Communications

5.1 How to write emails, letters and memos
5.2 Direct requests
5.3 Persuasive requests favorable/unfavorable replies, special message
5.4 Modern office technology for communication
5.6 Digital Citizenship/ Impact of ICT (emails, social media content)
5.7 Resume and Applications

5.8 Preparation and presentation of reports, Analytical reports, Informational reports, Monthly/annual reports, Conference reports, Progress proposals reports, Formal reports, Project reports.

Recommended Books

1. L. Puthery, "Personality Development and Communication Skills", SIA publishers (2018).
2. A. Clifford, Whitecomb, "Effective Interpersonal and Team Communication Skills for Engineers", Wiley, 1st Edition (2013).
3. J. W Davies, "Communication for Engineering Students", Longman (1995).

Teaching-learning Strategies

The teaching and learning strategy has been designed on the understanding of concepts and the ability to critically analyze and apply the learned content through lectures, discussion, activities, case studies using computer, multi-media and writing board instructional aids.

Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation (min. 2) will be submitted before the written exam of final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

II MME 212 Physical Metallurgy

- **Title:** Physical Metallurgy
- **Code Number:** MME 212
- **Semester:** 3rd
- **Credit hours:** 4 (3,1)
- **Theory Credit Hours:** 3 per week
- **Lab Credit Hours:** 1 per week
- **Lab Contact Hours:** 3 per week
- **Pre-requisites course:** Fundamentals of Metallurgy and Materials Engineering
- **Learning Outcomes:**

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

1. Comprehend fundamentals of crystallography.
2. Classify various phase diagrams and their importance in materials engineering.

Course Outline

Unit-1: Crystallography Overview

1.1 Bravais lattice & Space lattice
1.2 Crystal planes and Miller indices for crystallographic planes in unit cells
1.3 Directions in unit cells
1.4 Slip system in metallic systems
1.5 Packing density
1.6 Coordination number
1.7 Rotational and Reflection Symmetries
1.8 Ordered and Disordered solutions

Unit-2: Macro and microstructures

2.1 Formation of Grain boundaries and their defects
2.2 Low Angle Grain Boundaries
2.3 Grain size.

Unit-3: Solid Solutions

3.1 Constitution of Alloys
3.2 Metallic Solid Solutions (Interstitial and Substitutional solid solutions)
3.3 Solid Solubility

Unit-4: Phase Diagrams

4.1 Equilibrium Phase Diagrams & their types
4.2 Gibbs Phase Rule
4.3 Binary Isomorphous Alloy Systems
4.4 Nonequilibrium Solidification of Alloys
4.5 TTT diagram
4.6 Binary Eutectic Alloy Systems
4.7 Binary Monotectic Systems
4.8 Invariant Reactions
4.9 Phase Diagrams with Intermediate Phases and Compounds
4.10 Iron-Iron Carbide Equilibrium Diagram
4.11 Calculations related to phase diagrams
4.12 Ternary Phase Diagrams

Unit-5: Microstructure of Steels, Cast Irons and Non-Ferrous alloys

Unit-6: Metallography

7.1 Micro and macro examination
7.2 Chemical and Electrochemical Etching
7.3 Metallurgical Microscope.

Lab Outline: Practical pertaining to above mentioned topics.

Recommended Books

1. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley & Sons, Inc. 10th Edition (2018).
2. W.F. Hosford, "Physical Metallurgy", CRC Press Ltd. (2005).
3. S. H. Avner, "Introduction to Physical Metallurgy", Tata McGraw-Hill, Inc. (1997).

4. J. D. Verhoeven, "Fundamentals of Physical Metallurgy", John Wiley & Sons (1975).

Teaching-learning Strategies
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Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation / Open Ended Lab / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

III MME 213 Ceramics Science and Engineering

- **Title:** Ceramic Science and Engineering
- **Code Number:** MME 213
- **Semester:** 3rd
- **Credit hours:** 4 (3,1)
- **Theory Credit Hours:** 3 per week
- **Lab Credit Hours:** 1 per week
- **Lab Contact Hours:** 3 per week
- **Pre-requisites course:** Fundamentals of Metallurgy and Materials Engineering, Applied Chemistry
- **Learning Outcomes:**

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

1. Comprehend raw materials, structures, properties and applications of ceramic materials
2. Explain processing of ceramics
3. Analyze various defects in ceramics and remedies

Course Outline

Unit-1: Introduction

1.1 Classification and engineering applications of conventional and advanced ceramics

1.2 Overview of bonding and structural principles
1.3 Concept of octahedral and tetrahedral sites in unit cells

Unit-2: Ceramic structures

2.1 Cesium chloride
2.2 Rock salt
2.3 Zinc Blende
2.4 Flourite and Anti Flourite
2.5 Corundum
2.6 NiAs and NiS
2.7 Perovskite
2.8 Spinel and inverse spinel (ferrites)
2.9 Silicate structures
2.10 Synthesis of perovskite and ferrites
2.11 Pauling rules

Unit-3: Conventional ceramic raw materials

3.1 Clays (structure; types, properties and applications)
3.2 Non- plastic raw materials: Silica (minerals, metamorphism, applications, Conversion and inversions in silica);
3.3 Fluxes (feldspar, cornish stone, bone ash)

Unit-4: Firing of Traditional Ceramics

4.1 Thermal decomposition of clays
4.2 Triaxial white ware compositions
4.3 Firing and microstructural evolution in clay-based ceramics
4.4 Secondary processes in firing of clay-based ceramics (defects in ceramics)
4.5 Firing cycle for clay-based ceramics

Unit-5: Phase Diagrams and Imperfections

5.1 Imperfections in ceramics
5.2 Important Ceramic phase diagrams (MgO-Al_2O_3 System; ZrO_2-CaO system, ZrO_2-MgO system, SiO_2-Al_2O_3 System, Al_2O_3-Cr_2O_3 System)

Unit-6: Mechanical properties of ceramics

6.1 Strength of ceramics
6.2 Fracture toughness
6.3 Bend test
6.4 Fractography

Unit-7: Processing of Ceramics

7.1 Slip casting
7.2 Pressure casting
7.3 Hydroplastic forming
7.4 Tape casting
7.5 Powder pressing techniques
7.6 Gel casting
7.7 Major Operations in Ceramic Industry with flow sheet diagram
7.8 Sintering (conventional sintering, liquid phase sintering, microwave sintering, spark plasma sintering, etc.)

Uni-8: Refractories, Glazes and Cement

8.1 Classification, properties and applications (Alumina, Magnesite, Dolomite, Chromite, Rutile, Zirconia, Beryllia, Graphite)
8.2 Glazes
8.3 Cement: introduction, classification of cement, raw materials, important processes in cement industry

Unit-9: Glasses

9.1 Introduction
9.2 Types of Glasses
9.3 Composition of Glasses
9.4 Structure and properties of glasses
9.5 Glass forming techniques
9.6 Heat treatment of glasses

Unit-10: Advanced Ceramics (Alumina, SiC, graphite, SiN, $BaTiO_3$, Nanoclays, etc.)

Lab Outline: Practical pertaining to above mentioned topics

Recommended Books

1. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley and Sons, Inc, 10th Edition (2018).
2. Kingery, H. K. Bowen, et.al "Introduction to Ceramics", Wiley, 2nd Ed. (2004).
3. M. W Barsoum, "Fundamental of Ceramics" IOP (2003).
4. W. F. Smith, "Principles of Materials Science and Engineering", Mcgraw Hills, 3rd Edition (2003).
5. W. E. Worrall, "Ceramic Raw Materials", Pregamon Press, (1982).
6. W. Rayan, "Properties of Ceramic Raw Materials", Pregamon Press, 2nd Edition (1978).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Open Ended Lab / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

IV MME 214 Engineering Mechanics

- **Title:** Engineering Mechanics
- **Code Number:** MME 214
- **Semester:** 3rd
- **Credit hours:** 3 (3,0)
- **Theory Credit Hours:** 3 per week
- **Pre-requisites course:** Applied Physics
- **Learning Outcomes:**

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

1. Compute various linear, shear and torsional stresses in different types of structural members.
2. Calculate various stresses under combined loading using Mohr's circle.

Course Outline

Unit-1: Plain Stress & Plain Strain

1.1 Working Stresses
1.2 Unit Design
1.3 Strain Energy in Tension and Compression
1.4 Strain Energy in Shear
1.5 Principle Planes and principle axes and their determination
1.6 Stresses in thin walled Pressure Vessels
1.7 Mohr's circles of stress and strain

Unit-2: Inertia

2.1 Moment of Inertia along Different Axes
2.2 Polar Moment of inertia
2.3 Radius of Gyration
2.4 Ellipse of Inertia
2.5 Transfer formula for moment of inertia
2.6 Moment of inertia for composite areas
2.7 Mohr's circle for moment of inertia

2.8 Fault plate
2.9 Rectangular and Circular plate
2.10 Samples supported and clamped at the ends.

Unit-3: Torsion

3.1 Torsion of Circular Shafts (solid and hollow shafts)
3.2 Coiled Helical Spring
3.3 Torsion of thin walled tubes
3.4 Torsion of non-circular sections, General case of Plane Stresses

Unit-4: Shear Stress & Bending Moments

4.1 Principal Stress in Shear, Stresses due to combined Bending, Thermal Stresses
4.2 Buckling, Simple bending theory, General case of bending – Shear force and bending moment diagrams (Analysis of beams)
4.3 Relationship between loading, shear force and bending moment.

Recommended Books

1. F. P. Beer, "Mechanics of Materials", McGraw-Hill 6th Edition (2016).
2. A. Pytel, "Strength of Materials", Harper & Row Publishers, (2009).
3. M. F. Ashby, "Engineering Materials 1: An Introduction to Their Properties and Applications", Butterworth-Heinemann (2005).
4. P. P. Benham, "Mechanics of Engineering Materials", Pitman (2000).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

V MSC 215 Industrial Safety and Environmental Management

- **Title:** Industrial Safety and Environmental Management
- **Code Number:** MS 215
- **Semester:** 3rd
- **Credit hours:** 3 (3, 0)
- **Theory Credit Hours:** 3 per week
- **Pre-requisites course:** None
- **Learning Outcomes:**

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

1. Comprehend various hazards in industrial environment.
2. Apply safety measures to counter potential hazards in working environment i.e. PPE etc.
3. Demonstrate professional ethical responsibility in industrial safety and health.
4. Explain various forms of pollution and their remedies

Course Outline

Unit-1: Safety and Hazard

1.1 Introduction to Safety and Hazard safety management
1.2 Understanding accident and hazard
1.3 Hazard control and loss control
1.4 Accident Prevention and Control
1.5 Accident reporting and investigation
1.6 Fire safety
1.7 Types of fire Extinguishers
1.8 Electrical Safety, Safety in boilers
1.9 Safety in material handling and storage
1.10 Material safety data sheet (MSDS), COSHH and Risk assessment, Safety in production operations.

Unit-2: Process Safety Management

2.1 Development of facility operation and procedures
2.2 Analysis of process hazard
2.3 Hazard communication
2.4 Chemical inventory record
2.5 Industrial Hygiene and Workers Protection
2.6 Various hazards encountered in workplace
2.7 Types of personal protective equipment (PPE)
2.8 Availability in market, their design standards and selection criteria

Unit-3: Environment Management

3.1 Environment pollution
3.2 Air emission management
3.3 Waste management
3.4 Wastewater treatment and control
3.5 Soil and ground water protection
3.6 Introduction to Pakistan Environment Protection Act 1997 and National Environmental Quality Standards, Key elements of ISO 14000.

Recommended Books

1. M. J. Ray, “Industrial Safety Management”, Springer Nature (2018).
2. D. Della-Giustina, "Safety and Environmental Management", Government Institutes (2007).
3. R. Packman, “A Guide to Industrial Safety and Health”, Longmans (2007).
4. T. J. Anton, “Occupational Safety & Health Management”, McGraw-Hill (2006).
5. J. S. Angle, “Occupational Safety”, Thomson Delmar Learning (2004).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

VI HUM 216 The Holy Quran Translation

- **Title:** The Holy Quran Translation
- **Code Number:** HUM 216
- **Semester:** 3rd
- **Credit Hour:** 1 per week
- **Pre-requisites course requirements/ skills:** -
- **Learning Outcomes:**

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

1. Understand the translation and explanation of the Holy Quran
2. Demonstrate and practice the way of life in the light of teachings of Holy Quran

Course Outline

The students will learn Holy Quran with translation in this module. The course outline will be as approved by Academic Council of University of the Punjab.

Fourth Semester

I MME 221 Mechanical Behaviour of Engineering Materials

- **Title:** Mechanical Behaviour of Engineering Materials
- **Code Number:** MME 221
- **Semester:** 4th
- **Credit hours:** 4 (3,1)
- **Theory Credit Hours:** 3 per week
- **Lab Credit Hours:** 1 per week
- **Lab Contact Hours:** 3 per week
- **Pre-requisites course:** Engineering Mechanics, Physical Metallurgy
- **Learning Outcomes:**

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

1. Explain plastic and elastic deformation phenomenon of engineering materials.
2. Comprehend basic knowledge of fracture mechanics under various circumstances.

Course Outline

Unit-1: Deformation

1.1 Introduction to Mechanical behaviour of Materials
1.2 Types of Stresses and Strain
1.3 Elastic and Plastics Deformation
1.4 Hardness
1.5 Crystal defects/imperfections (point defects, line defects) and their role

Unit-2: Dislocations

2.1 Dislocation Vectors and Dislocation Loop
2.2 Edge & screw dislocations and their movements
2.3 Mixed dislocations
2.4 Dislocation density
2.5 Motion of dislocations (Glide & Climb mechanisms)
2.6 Dislocations in FCC, BCC & CPH Lattices
2.7 Stress Fields and Energies of Dislocations
2.8 Forces on Dislocations & Forces between Dislocations
2.9 Intersection of Dislocations (Jogs & Kinks)
2.10 Dislocation-Point Defect Interactions
2.11 Dislocation Pileups, Dislocation Sources
2.12 Multiplication of Dislocations
2.13 Grain Boundaries and Deformation
2.14 Critical Resolved Shear Stress for Slip
2.15 Twinning & deformation by Twinning, Stacking Faults

Unit-3: Plastic Deformation

3.1 Plastic deformation/Stress Strain behaviour of a single crystal and poly-crystalline material
3.2 Deformation of Face-Centered Cubic Crystals

3.3 Yield Point Phenomenon, Bauschinger Effect
3.4 Hall-Petch relationship
3.5 Effect of preferred orientation (Texture)
3.6 Grain boundary strengthening
3.7 Solid solution strengthening
3.8 Strain hardening & strain aging
3.9 Strain Hardening of Single Crystals
3.10 Micro-strain behaviour, Cold Working, Hot working (Recovery, Recrystallization and Grain Growth).

Unit-4: Fracture

5.1 Introduction to Fracture Mechanics
5.2 Types of Fractures
5.3 High temperature fracture
5.4 Impact Fracture Testing, Creep and Fatigue Properties
5.5 Relationship of Mechanical Properties and Microstructure

Unit-5: Mechanical behaviour of Ceramics and Polymers

Lab Outline: Practical pertaining to above mentioned course outlines.

Recommended Books

1. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley & Sons, Inc., 10th Edition (2018).
2. T. H. Courtney, "Mechanical Behavior of Materials", McGraw-Hill (2000).
3. F. Karim, "Testing of Engineering Ceramics and Plastics", Ferozsons (Pvt.) Ltd. (1998).
4. W. F. Smith, "Principles of Materials Science and Engineering", McGraw-Hill (1995).

Teaching-learning Strategies

The teaching and learning strategy has been designed on the understanding of concepts and the ability to critically analyze and apply the learned content through lectures, discussion, activities, case studies using computer, multi-media and writing board instructional aids.

Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Open Ended Lab / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements		Weightage	Details
1.	Midterm Assessment		35%	Written or MCQ-based* examination at the mid-p the semester.
2.	Formative Assessment		25%	It includes: classroom participation, attendance presentations and assignments.
3.	Final Assessment		40%	Written examination at the end of semester.

II MME 222 Polymer Science and Engineering

- **Title:** Polymer Science and Engineering
- **Code Number:** MME 222
- **Semester:** 4th
- **Credit hours:** 3 (3, 0)
- **Theory Credit Hours:** 3 per week
- **Pre-requisites course:** Fundamentals of Metallurgy and Materials Engineering, Applied Chemistry
- **Learning Outcomes:**

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

1. Comprehend chemistry, structure, properties and applications of polymeric materials.
2. Explains processing techniques of polymeric materials.
3. Analyze various defects formed in plastics after processing and suggest their remedies.

Course Outline

Unit-1: Introduction to polymers

1.1 Introduction to polymer, resins and polymeric material
1.2 Plastic industry
1.3 Natural polymers
1.4 Raw materials for polymers
1.5 Polymerization (mechanism and techniques)
1.6 General classification of polymers

Unit-2: Micro Structures in Polymers

2.1 Bonding and Bonding in polymers (thermoplastics, thermosetting polymers)
2.2 Molecular weight of polymers, melt index,
2.3 Structure and behaviour of polymers
2.4 Steric effects
2.5 Linear polymers, branched chain, crosslinked and network polymers
2.6 Polymer crystallinity
2.7 Thermal transitions in polymers (glass transition, heat distortion temperature, melting point and degradation)

2.8 Thermal characterization of polymers
2.9 Viscoelasticity
2.10 Diffusion in polymers

Unit-3: Mechanical Behaviour of Polymers

3.1 Deformation of polymers
3.2 Mechanical properties of polymers
3.3 Methods for increasing strength of polymers

Unit-4: Elastomers and Copolymers

4.1 Polymer alloys
4.2 Blends and copolymers
4.3 Elastomers (structure, properties, vulcanization, processing, types and applications)
4.4 Natural rubber

Unit-5: Engineering Plastics

5.6 Properties and applications of some important polymeric materials (natural rubber and synthetic rubber, polyethene, polypropylene, polystyrene, acrylonitrile butadiene styrene, polyvinyl chloride, silicones, phenolics, Teflon, polystyrene, nylon, Bakelite, melamine, polyester, polyurethane, epoxies, polycarbonate, polysulphone, polyether ether ketone, flouroelastomers, etc), copolymers of polyethene, polystyrene
5.7 Polymers used in paint, biomedical, sports, automotive and composite industries.

Unit-6: Degradation and Stabilization of Polymers

6.1 Degradation of polymers
6.2 Polymer additives
6.3 Environmental aspects polymeric materials,

Unit-7: Processing of Polymers

7.1 Polymer forming techniques (extrusion moulding, injection molding, blow molding, thermoforming, clandering, drawing, foaming, casting, spinning, compression and resin transfer moulding, rotational molding, etc)
7.2 Problems related to polymer processing and their remedies
7.3 Designing with plastics
7.4 Operations in plastic manufacturing industries

Unit-8: Advanced polymers

Recommended Books

1. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley and Sons, Inc, 10th Edition (2018).
2. F.W. Billmeyer, "TextBook of Polymer Science", 3rd Edition (2013).
3. P. Bahadur, "Principles of Polymer Science", Narosa publishing house (2003).
4. W. F. Smith, "Principles of Materials Science and Engineering", McGraw Hills, 3rd Edition (2003).
5. Sinha, "Outlines of Polymer Technology: Manufacture of Polymers", Phi learning (2002).
6. A. Brent Strong, "Plastics: Materials and Processing", 2nd Edition (2000).
7. M. Chanda and S. K. Roy, "Plastics Technology Handbook", CRC Press (1998).

Teaching-learning Strategies
The teaching and learning strategy has been designed on the understanding of concepts and the ability to critically analyze and apply the learned content through lectures, discussion, activities, case studies using computer, multi-media and writing board instructional aids.

Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation / Open Ended Lab / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

III MME 223 Materials Thermodynamics and Kinetics

- **Title:** Materials Thermodynamics and Kinetics
- **Code Number:** MME 223
- **Semester:** 4th
- **Credit hours:** 3 (3, 0)
- **Theory Credit Hours:** 3 per week
- **Pre-requisites course:** Applied Chemistry
- **Learning Outcomes:**

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

1. Comprehend the application of thermodynamics in engineering processes like alloy melting, heat treatment, corrosion etc.
2. Apply thermodynamic principles to various processes such as oxidation, reduction, extraction, refining processes.

Course Outline

Unit-1: Fundamentals of Thermodynamics

1.1 Overview of fundamentals of classical thermodynamics
1.2 Types of thermodynamics
1.3 Thermochemistry and Thermo-Physics.
1.4 Zeroth Law of Thermodynamics

1.5 Thermodynamic functions
1.6 Use of thermodynamic data

Unit-2: First Law of Thermodynamics

2.1 Overview of Heat, Work, Internal energy & Enthalpy
2.2 Different types of heat (enthalpy) of reaction (Heat of formation. Standard heat of formation & reaction. Heat of combustion, solution and neutralization). Application of Heat of combustion (Calculation of "heat of formation" and "calorific values").
2.3 Overview of heat capacity. Molar heat capacity and its types. Molar specific heat at constant pressure and at constant volume
2.4 Numerical examples.

Unit-3: Second Law of Thermodynamics

3.1 Overview of entropy
3.2 Entropy change with Temperature and Volume as variables (Constant Pressure)
3.2 Entropy change with Temperature and Pressure as variables (Constant Volume)
3.4 Entropy changes at Constant Volume, at constant Pressure and at constant Temperature.
3.5 Numerical examples

Unit-4: Third Law of Thermodynamics

4.1 Absolute entropies
4.2 Overview of free energy and its types (Gibb's & Helmholtz free energies)
4.3 Gibb's free energy with Pressure variables and Volume variables
4.4 Hess's law & its application. Energy changes during transitions or phases change (Heat of fusion, -vaporization, –sublimation, –transition)
4.5 Maxwell relation
4.6 Gibb's-Helmholtz equation

Unit-5: Introduction to property diagrams

5.1 Pressure-Temperature (P-T) Diagram
5.2 Pressure-Specific Volume (P-v) Diagram
5.3 Pressure-Enthalpy (P-h) Diagram
5.4 Enthalpy-Temperature (h-T) Diagram
5.5 Temperature-Entropy (T-s) Diagram and Enthalpy-Entropy (h-s) or Mollier Diagram.

Unit-6: Equilibria

6.1 Equilibrium and its types
6.2 Criterion of equilibrium
6.3 Phase equilibria & free energies
6.4 Effect of temperature and pressure on equilibrium constant
6.5 Gibb's phase rule. Metal-slag equilibria. Chemical equilibria and condensed phase
6.6 Phase equilibria in single and multiphase component systems
6.7 Half-cell reactions
6.8 Multicomponent phase diagrams in ceramics and gas-solid equilibria
6.9 Euler equation and Auxiliary functions
6.10 Polymer thermal stability in chemical environments

Unit-7: Thermodynamics of phase transformations

7.1 First order and second order transformations
7.2 Statistical thermodynamics
7.3 Applications of laws of thermodynamics in phase diagrams
7.4 Ellingham Diagram

7.5 Fugacity
7.6 Vapor-liquid equilibrium with a non-ideal vapor phase

Unit-8: Chemical Kinetics

8.1 Introduction to non-equilibrium thermodynamics
8.2 Arrhenius Equation
8.3 Energy profile
8.4 Activation Energy
8.5 Types of Chemical Reactions (Homogeneous and Non-Homogenous)
8.6 Rate of Reaction, Rate law or Rate equation
8.7 Order of reaction, Rate constant, Zero–, First– & Second Order Reaction
8.8 Half Life of reaction
8.9 Molecularity of a reaction
8.10 Molecularity of Elementary reaction,
8.11 Pseudo Order Reaction
8.12 Collision theory of Reaction Rates.

Recommended Books

1. Y. A. Chang, W. Alan Oates, "Materials Thermodynamics (Wiley Series on Processing of Engineering Materials)", Wiley Series, 2nd Edition (2015).
2. Y. A. Cengel, "Thermodynamics: An Engineering Approach", 5th Edition (2010).
3. A. Bahl, B.S. Bahl, et al. "Essentials of Physical Chemistry", S. Chand (2000).
4. R. Joel, "Basic Engineering Thermodynamics", Longman (1996).
5. D. R. Gaskell, "Introduction to Metallurgical Thermodynamics", Taylor & Francis (1981).
6. G. S. Upadhyaya et.al "Problems in Metallurgical Thermodynamics and Kinetics", Pergamon, (1977).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes /Complex Engineering Problems will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

IV MME 224 Foundry Engineering-I

- **Title:** Foundry Engineering-I
- **Code Number:** MME 224
- **Semester:** 4th
- **Credit hours:** 2 (2,1)
- **Theory Credit Hours:** 2 per week
- **Lab Credit Hours:** 1 per week
- **Lab contact hours:** 3 per week
- **Pre-requisites course:** Fundamentals of Metallurgy and Materials Engineering, Physical Metallurgy
- **Learning Outcomes:**

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

1. Comprehend the functions of various raw materials, patterns and cores for moulding process.
2. Explain various casting manufacturing routes, machines in foundry and related defects.

Course Outline

Unit-1: Casting

1.1 Metal casting: a process of shaping
1.2 Comparison of casting method with other shaping techniques
1.3 Process flow for production of casting
1.4 Classification of foundries
1.5 Process selection
1.6 Mold boxes with illustration of other parts/channels in a mold making process.

Unit-2: Patterns

2.1 Functions of patterns
2.2 Types of patterns
2.3 Pattern Materials and allowances.

Unit-3: Foundry Sands

3.4 Mold & core sands (types, properties & ingredients)
3.5 Binders and additives

3.6 Testing of mold and core sands
3.7 Facing vs backing sands
3.8 Mold and core coatings

Unit-4: Molds and Mold Making

4.1 Sand molding (Green sand, Shell, Cement bonded, CO_2 process, Reisen bonded, Molasses molding etc.).
4.2 Effect of molding on sand properties
4.3 Flask-less molding
4.4 Ceramic molding
4.5 Plaster molding
4.6 Permanent molds
4.7 Die Casting (pressure and gravity die castings)
4.8 Centrifugal casting. Investment casting

Unit-5: Cores and Core Making

5.1 Ingredients of core sand
5.2 Properties of sand cores
5.3 Binders for cores
5.4 Core boxes and core making
5.5 Core baking
5.6 Finishing of cores
5.7 Core setting.
5.8 Chaplets & their usage

Unit-6: Molding Equipment, Mechanization & pollution control

6.1 Molding machines (operation and maintenance)
6.2 Molding equipment
6.3 Core shooters
6.4 Approach to foundry mechanization
6.5 Material handling systems (Sand plant, Molding line mechanization, Sand reclamation).
6.6 Automation – High pressure molding line
6.7 Stack molding
6.8 Pollution control systems (Dust and fume control, furnace emission control systems, Noise control

Unit-7: Fettling & Inspection of Casting

7.1 Removal of gating system (equipment & machines Rough cleaning including flogging, mechanical cut off, torch cutting
7.2 Surface cleaning – exterior and interior (equipment and machines) including tumbling, blasting and other types of surface cleaning
7.3 Final surface cleaning & trimming including dripping, grinding, stand grinding, finishing of castings
7.4 Inspections of casting including visual, dimensional and metallurgical procedures

Unit-8: Furnaces and their design

8.1 Different designs and operational procedure of a foundry Cupola, Induction furnace, Rotary furnace etc.

Lab Outline: Practical pertaining to above mentioned course outlines.

Recommended Books

1. R. W. Heine, C. R. Loper and P.C. Rosenthal, "Principles of Metal Casting", Tata McGraw-Hill, Inc. (2014).
2. J. Campbell, "Castings", Butterworth-Heinemann (2003).
3. J. R. Brown, "The Foseco Non-Ferrous Foundryman's Handbook", Butterworth-Heinemann, (1999).
4. N. K. Srinivisan, "Foundry Engineering", Khanna Tech. Publications India (1991).
5. R. A. Flinn, "Fundamentals of Metal Casting", Addison Wesley Inc. (1983).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Open Ended Lab / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

V CSC 225 MATLAB and SIMULINK

- **Title:** MATLAB & SIMULINK
- **Code Number:** CSC 225
- **Semester:** 4th
- **Lab Credit hours:** 1 per week
- **Lab contact hours:** 3 per week
- **Pre-requisites course:** Introduction to Computer Science and Information Technology
- **Learning Outcomes:**

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

1. Comprehend the general concepts of programming and obtain a solid foundation in the use of MATLAB.
2. Write moderate-size programs that solve engineering problems

Course Outline

Unit-1: Introduction to Programming

1.1 Program, languages, and compilation process

Unit-2: MATLAB

2.1 MATLAB environment
2.2 Syntax and semantics
2.3 creating plots in MATLAB
2.4 Matrices and Operators
2.5 Introduction to simple program coding, executing and debugging involving Input /Outputs, Variables, Conditions and logical operators, If / else, loops (for, while
2.6 Matrices (single / multidimensional)
2.7 Functions (Built-in / self-defined)
2.8 Plots
2.9 Engineering Applications in MATLAB

Unit-3: Introduction to SIMULINK

Unit-4: Development of flowchart and corresponding pseudo codes

Lab Outline: Practical pertaining to above mentioned course outline.

Recommended Books

1. W. Boober, "MATLAB Essentials: A First Course for Engineers and Scientists", CRC Press (2018).
2. H. Moore, "MATLAB for Engineers", Pearson (2017)
3. M. Delores, "Introduction to MATLAB", Prentice Hall, 3rd edition (2014)
4. A.K.S Timothy, "MATLAB Primer", CRC Press, 7th Edition (2004).

Teaching-learning Strategies

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Assessment and Examination of Lab

Grades of Lab course are finalized on the basis of students' performance in each lab. Each lab will be graded on the basis of Psychomotor (70%), Cognitive (20 %) and Affective (10%) domain according to the OBE guidelines defined by Pakistan Engineering Council.

VI CSC 226 Computer Aided Design

- **Title:** Computer Aided Design
- **Code Number:** CSC 226
- **Semester:** 4th
- **Lab Credit hours:** 1 per week
- **Lab contact hours:** 3 per week
- **Pre-requisites course:** Engineering Drawing
- **Learning Outcomes:**

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

1. Comprehend the basics of modern designing software.
2. Use computer-based software to design engineering objects in different angle of projections.

Lab Outline

CATIA® software for the designing of engineering products will be taught in this lab.

Teaching-learning Strategies

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VII HUM 227 Technical Writing

- **Title:** Technical Writing
- **Code Number:** HUM 227
- **Semester:** 5th
- **Credit hours:** 2 (2, 0)
- **Pre-requisites course:** English, Communication Skills
- **Learning Outcomes:**

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

1. Assess the role of visual communication in simplifying and comparing information and illustrating trends and ideas.
2. Determine the components and qualities of an effective letter and circular.
3. Explain the salient features of the persuasive letters and circulars.
4. Describe the contents of a business report.
5. Prepare scientific reports, summaries, manuals, guides and business communications.

Course Outline

Unit-1: Features of Technical writing

1.1 Defining features of technical writing
1.2 Nature & Taxonomy of technical writing

Unit-2: Technical writing basics (structuring, positioning, conciseness, 7 C's)
Unit-3: The importance of audience awareness
Unit-4: Style of writing, Composition, Graphic detail, Editing process
Unit-5: Formatting technical reports, business reports and communications
Unit-6: Writing research papers and review reports, Proposal and other short reports
Unit-7: Writing Progress report
Unit-8: Writing Inspection and Test Reports
Unit-9: Publishing your work

Recommended Books

1. P. A. Laplante, "Technical Writing: A Practical Guide for Engineers, Scientists, and Nontechnical Professionals", Boca Raton, 2nd Edition (2018).
2. L.G. Kirszner, L. G., S.R. Mandell, "Patterns for college writing: A rhetorical reader and guide", Macmillan (2011).
3. B, D. McMurrey, et al., "A Guide to Writing as an Engineer" Wiley & Sons, 3rd Edition (2009).

Teaching-learning Strategies
The teaching and learning strategies have been designed on the understanding of concepts and the ability to critically analyse and apply the learned content through lectures, discussion, activities, case studies using computer, multi-media and writing board instructional aids.

Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation will be submitted before the written exam of final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

Fifth Semester

I MME 311 Iron Manufacturing

- **Title:** Iron Manufacturing
- **Code Number:** MME 311
- **Semester:** 5th
- **Credit hours:** 2
- **Pre-requisites course:** Applied Chemistry, Mineral Processing. Materials Thermodynamics and Kinetics
- **Learning Outcomes:**

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

1. Explain the operational procedure and products of blast furnace.
2. Comprehend alternative routes of iron making other than BF.
3. Calculate Charge for blast furnace.

Course Outline

Unit-1: Introduction to Iron Making and Raw Materials

1.1 Evolutionary advancement in Iron making Process
1.2 The Blast Furnace Burden; Iron Ores, Geologic/Geographic Occurrence, Classification and Valuation
1.3 Preparation for Blast furnace feed; comminution, Assay building and Agglomeration
1.4 Blast furnace Fuels
1.5 Metallurgical Coals and their classification
1.6 Carbonization Process for coke making
1.7 Quality and features of required metallurgical coke, Natural gas
1.8 Blast furnace Flux
1.9 Classification-selection-preparation of BF, Air pre-heating into stoves for Blast furnace supply

Unit-2: The Blast Furnace

2.1 Designing Parameters
2.2 Structure and Material of Construction
2.3 Refractories
2.4 Auxiliary Equipment
2.5 Operation
2.6 Irregularities in operation and Trouble Shooting

Unit-3: The Physical Chemistry of Iron Making

3.1 Metallurgical thermodynamics of iron making
3.2 Involvement of Free energy & oxygen potential
3.3 Ellingham diagrams
3.4 Chemical Kinetics and Mechanism of BF reactions
3.5 Combustion, Reduction and Slag Making Reaction
3.6 Analytical approach to CO-CO_2 Ratio
3.7 Material & Energy Balance

3.8 Charge calculations of BF

Unit-4: Blast Furnace Products

4.1 Hot Iron / Pig Iron, chemical composition, grades, Uses etc.,
4.2 Slags: Structure and composition, Basicity, Functions and features of good slag, Uses
4.3 Analytical approach to calculate basicity and flux requirements.

Unit-5: Blast Furnace Effluent gases

5.1 Thermochemistry and Chemical composition
5.2 Disposal and treatment of BF gas

Unit-6: Modernization in Iron making Process

6.1 Up-gradation in equipment
6.2 Software incorporation
6.3 Processing Techniques
6.4 Iron Making process at Pakistan steel
6.5 Equipment and products of Pakistan Steel
6.6 Iron and steel making in Pakistan

Unit-7: Introduction to Cast Irons

7.1 Various types of Cast Irons
7.2 Manufacturing techniques & alternative routes other than BF
7.3 Classification, techniques and equipment used for adopting the direct methods of Iron or steelmaking – use of HBI and DRI etc.

Recommended Books

1. A. H. Hiorns, “Iron and Steel Manufacture”, Andesite Press (2017).
2. R. H. Tupkary, et al., "An Introduction to Modern Iron Making", Khanna Publishers (2010).
3. S. H. Avner, "An Introduction to Physical Metallurgy", Tata McGraw-Hill, Inc., 2nd Edition (2010).
4. J.J. Moore, "Chemical Metallurgy", Butterworth-Heinemann (1990).
5. J. G. Peacey, W. G. Daveonport, "The Iron Blast Furnace", Pergamon Press (1979).
6. C. Bodsworth, "Physical Chemistry of Iron and Steel Manufacture", Prentice Hall (1972).
7. A. Butts, "Metallurgical Problems", McGraw-Hill Book Company, (1971).
8. H. E. McGannon, "The Making, Shaping and Treating of Steel", USS, 9th Edition (1971).
9. R. H. Parker, "An Introduction to Chemical Metallurgy", Pergamon (1967).
10. J. Newton, "Extractive Metallurgy", John Wiley & Sons Inc (1959).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

II MME 312 Foundry Engineering II

- **Title:** Foundry Engineering-II
- **Code Number:** MME 312
- **Semester:** 5th
- **Credit hours:** 4 (3, 1)
- **Pre-requisites course:** Foundry Engineering-I, Physical Metallurgy
- **Learning Outcomes:**

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

1. Comprehend solidification phenomenon of pure metals and alloys.
2. Explain manufacturing routes of various metals, alloys and related metal treatment processes.
3. Calculate most favourable gating system for a particular casting.

Course Outline

Unit-1: Solidification of metals

1.1 Introduction
1.2 Phase transformation
1.3 Freezing of a pure metal
1.4 Solidification in a mold (Dendritic solidification)
1.5 Concept of Carbon equivalent
1.6 Charge calculations of various alloys
1.7 Thermal analysis of liquid during solidification
1.8 Solidification phenomenon (Nucleation & Growth process, Spinodal decomposition),
1.9 Family of cast irons their solidification and manufacturing
1.10 Inoculation practices
1.11 Effects of alloying elements in cast irons

Unit-2: Riser Design

2.1 Primary functions of riser
2.2 Chvorinov's rule and other theoretical considerations of risers including riser shape, riser neck, riser size and location of risers

2.3 Design consideration of risers
2.4 Directional solidification, Use of chills, insulators and exothermic compounds

Unit-3: Gating system Design

3.1 Elements of the gating system
3.2 Essential requirements of gating system
3.3 Characteristics of pouring cups, sprue, runners and ingates, Gating ratio
3.4 Pressurized and un-pressurized gating systems
3.5 Casting design considerations
3.6 Theoretical considerations of gating system.

Unit-4: Treatment of Alloys

4.1 Al-based, Cu-based and other foundry alloys
4.2 Degasification and modification
4.3 Treatment with cover and cleaning fluxes
4.4 Filtration of aluminium alloy castings

Unit-5: Casting defects & Analysis

5.1 Occurrence and appearance of various casting defects
5.2 non-metallic inclusions for common foundry alloys and defects due to improper gating design
5.3 Defect analysis (procedure and approach)

Lab Outline: Practical pertinent to above mentioned course.

Recommended Books

1. R. W. Heine, C. R. Loper and P.C. Rosenthal, "Principles of Metal Casting", Tata McGraw-Hill, Inc. (2014).
2. J. Campbell, "Castings", Butterworth-Heinemann (2003).
3. P. Beeley, "Foundry Technology", Butterworth-Heinemann (2001).
4. J. R. Brown, "The Foseco Non-Ferrous Foundryman's Handbook", Butterworth-Heinemann, 11th Edition (1999).
5. J. R. Brown, "The Foseco Foundryman's Handbook", Butterworth-Heinemann, 10th Edition (1999).
6. R. W. Heine, C. R. Loper et al. "Principles of Metal Casting", Tata McGraw-Hill (1976).
7. R. Elliot, "Cast Iron Technology", Butterworth-Heinemann (1988).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Open Ended Lab / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

III MME 313 Heat Treatment of Metals and Alloys

- **Title:** Heat Treatment of Metals and Alloys
- **Code Number:** MME 313
- **Semester:** 5^{th}
- **Credit hours:** 4 (3, 1)
- **Pre-requisites course:** Physical Metallurgy
- **Learning Outcomes:**

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

1. Comprehend the science behind various heat treatment processes.
2. Apply the knowledge of various heat treatment processes to develop required microstructures.

Course Outline

Unit-1: Introduction to Heat Treatment

1.1 Objectives
1.2 Types and applications of various heat-treatment (HT) processes
1.3 Effect of alloying elements on the upper and lower critical temperature lines of the Iron-iron carbide (ICC) equilibrium diagram

Unit-2: Phase Transformations

2.1 Solid-solid phase transformations
2.2 Diffusional and Non-diffusional transformations
2.3 Nucleation; Homogeneous and Heterogeneous in solid state transformation.

Unit-3: Types of heat-treatment furnaces

Unit-4: Annealing

4.1 Purpose, Applications
4.2 Factors and cycle of annealing
4.3 Types of Annealing (Full, Iso-thermal, Partial, Recrystallization, Process, Graphitizing and Spheroidizing annealing)

Unit-5: Normalizing

5.1 Objective of normalizing

5.2 Applications
5.3 Process of Normalizing
5.4 Annealing versus normalizing.

Unit-6: Hardening

7.1 The theory of hardening process
7.2 Quenching
7.3 Factors affecting the Quenching process and its applications
7.4 Hardening methods: Direct quenching, Stage wise quenching, Spray quenching (Cooling rate, Removal of heat during quenching – the science, Quenching characteristics, Quenching media, microstructure of as-quenched product),
7.5 Hardenability
7.6 Jominy end-quench test for hardenability evaluation

Unit-7: Tempering

7.1 Purpose of tempering and microstructural changes
7.2 Aims of tempering, Types of tempering (Low, medium and high temperature tempering)
7.3 Effect of alloying elements on tempering
7.4 Tempered martensite
7.5 Temper embrittlement
7.6 Martempering
7.7 Austempering: Objective, Applications and heat-treatment cycle
7.8 Various Types of Bainite

Unit-8: Surface Hardening

8.1 Flame hardening & its types
8.2 Induction hardening
8.3 Case hardening by metallic diffusion (Aluminum, Zinc, Chromium)
8.4 Case hardening by non-metallic diffusion (Carburizing, Nitriding, Cyaniding, Nitro-carburizing, chromizing, Boriding, Aluminizing, Siliconizing, Sherardizing)
8.5 Types of Carburizing (Pack, Gas & Liquid carburizing)

Unit-9: Age Hardening/precipitation hardening

Unit-10: Defects

10.1 Oxidation and decarburization during heat treatment
10.2 Defects caused during heat treatment processes and their remedies

Unit-11: Subzero Heat treatment

Unit-12: Advance Heat Treatment

12.1 Effect of Grain Size and Morphology on Mechanical properties
12.2 Thermo-mechanical Treatment (TMT) of steel bar during rolling process
12.3 Advance heat-treatment Processes: Quenching and Partitioning; Quenching, Partitioning and Tempering.

Lab Outline: Practical pertinent to above mentioned course.

Recommended Books

1. E. Oberg, “Heat treatment of Steel”, Owen Press (2016).
2. S. H. Avner, "An Introduction to Physical Metallurgy", Tata McGraw-Hill, Inc., 2nd Edition (2010).
3. R. W. K. Honeycombe et al. “Steels: Microstructure and Properties”, Butterworth-Heinemann, (2006).
4. G. E. Totten, "Steel Heat Treatment: Metallurgy and Technologies", CRC Press (2006).
5. J. W. Christian, “The Theory of Transformations in Metals and Alloys”, Pergamon (2002).
6. D. A. Porter et al. “Phase Transformations in Metals and Alloys”, Chapman and Hall (2001).
7. R. E. Smallman et al. "Modern Physical Metallurgy and Materials Engineering", Butterworth-Heinemann (1999).
8. J. W. Martin, "Precipitation Hardening", Butterworth-Heinemann (1998)
9. Ge. Krauss, "Steels: Heat Treatment and Processing Principles", ASM International (1990).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Open Ended Lab / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

IV MME 314 Transport Processes

- **Title:** Transport Processes
- **Code Number:** MME 314
- **Semester:** 5th
- **Credit hours:** 3 (3, 0)
- **Pre-requisites course:** Applied Physics & Applied Chemistry, Materials Thermodynamics and Kinetics
- **Learning Outcomes:**

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

1. Analyse the problems of compressible/incompressible fluid flow and the mechanisms of fluids motion with the applications of momentum and energy equations.
2. Solve problems related to heat transfer in engineering applications
3. Apply knowledge of mass transfer to heat treatment processes.

Course Outline

Unit-1: Heat Transfer

1.1 Modes of Heat transfer
1.2 Heat conduction equation
1.3 Boundary conditions
1.4 Steady state and transient heat conduction
1.5 Concept of thermal resistance
1.6 Forced and natural convection
1.7 Radiation heat transfer
1.8 Heat transfer in engineering practice; furnaces, heat exchangers, electronic components and buildings.

Unit-2: Diffusional Studies

2.1 Mass transfer
2.2 Mass diffusion
2.3 Boundary conditions
2.4 Fick's first & second law of diffusion
2.5 Steady & non-steady state diffusion
2.6 Transient mass diffusion
2.7 Mass transfer through solid-state diffusion
2.8 Self-diffusion, Volume and grain boundary diffusion
2.9 Analogy between heat transfer and mass transfer
2.10 Mathematical calculation of metallurgical processes.

Unit-3: Fluid Flow

3.1 Nature of fluid flow
3.2 Properties of fluids
3.3 Buoyancy
3.4 Compressibility
3.5 Relationship between depth and pressure
3.6 Pascal's Law
3.7 Equation of Continuity

3.8 Flow regimes
3.9 Laminar & turbulent flow
3.10 Ideal fluid, Reynolds Number
3.11 Simplified & extended Bernoulli Equation

Unit-4: Viscosity and Flow meters

4.1 Viscosity of gases, liquid metals, alloys and slags
4.2 Differential mass and momentum balances
4.3 Applications of differential balance equations
4.4 Viscosity determination by; Stoke's method and Concentric cylinder method. Head Loss, Friction factor, Darcy's Equation, Overall mechanical energy balance
4.5 Flow meters (pitot tube, orifice meter, nozzle venturi meter, rotameter)
4.6 High speed flow of gases related to steel making processes.

Recommended Books

1. D. Poirier, "Transport phenomenon in materials processing", Springer (2016).
2. J. M. Coulson and J. F. Richardson, "Coulson & Richardson's Chemical Engineering", Butterworth-Heinemann (2007).
3. Y. A. Cengel, Heat transfer, A practical approach, McGraw-Hill, 2nd Edition (2003)
4. A.K. Mohanty, Rate Processes in Metallurgy, Printce Hall (2000)

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

V MME 315 Metallurgical Manufacturing Processes

- **Title:** Metallurgical Manufacturing Processes
- **Code Number:** MME 315
- **Semester:** 5th
- **Credit hours:** 3
- **Pre-requisites course:** Engineering Mechanics, Mechanical behavior of Engineering Materials
- **Learning Outcomes:**

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

1. Comprehend fundamentals of different manufacturing processes
2. Select a suitable manufacturing process to produce a given component

Course Outline

Unit-1: Shaping Processes

1.1 Introduction to Shaping Processes and Classification
1.2 Structure-Property-Processing Relationship

Unit-2: Plasticity

2.1 Theory of plasticity
2.2 Flow stress determination
2.3 Temperature and strain-rate effects
2.4 Friction & wear and other fundamentals of metal forming
2.5 Fundamentals of metal working
2.6 Cold and Hot Working of Metals

Unit-3: Classification of mechanical working processes

4.1 Forging (Open die hammer forging, Die drop forging, Press forging, Upset forging, Roll forging, Near net shape forging)
4.2 Extrusion & its methods
4.3 Extrusion of hollow shapes
4.4 Cold working processes (Squeezing, Bending, Shearing, & Drawing processes such as Rolling, extrusion, Sizing, Riveting, Coining, Peening, Burnishing, Thread rolling, Angle bending, Roll bending, Roll forming, Seaming, Flanging, Straightening, Shearing, Blanking, Perforating, Notching, Nibbling, Shaving, Trimming)
4.5 Embossing & Stretch forming
4.6 Tube and wire drawing
4.7 Sheet metal forming process
4.8 Ericson-cupping test for sheet metal forming

Unit-4: Machining, Rolling and its principles

4.1 Types of rolling mills and its design calculations
4.2 Rolling of ingot, bloom, billets, sheet, bars, rods and structural components
4.3 Thermo-mechanical Treatment
4.4 Stamping and Deep Drawing
4.5 Manufacturing defects causes and remedies
4.6 Quality control in manufacturing processes
4.7 CAD/CAM technology

4.8 Additive manufacturing
4.9 3D printers for manufacturing. Introduction to non-conventional manufacturing processes such as water jet cutting and plasma cutting

Recommended Books

1. H.A. Youssef et al., "Manufacturing Technology: Materials, Processes, and Equipment", CRC press (2011).
2. M. P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", John Wiley & Sons, Inc. (2007).
3. H. Geng, "Manufacturing Engineering Handbook", McGraw-Hill (2004).
4. S. Kalpakjian et.al "Manufacturing Processes for Engineering Materials", Pearson Education, Inc., (2003).
5. E. P. DeGarmo, J. T. Black et.al "Materials and Processes in Manufacturing", Wiley (2002).
6. R. C. Creese, "Introduction to Manufacturing Processes and Materials", Taylor and Francis, (1999).
7. B. H. Amstead, P. F. Ostwald and M. L. Begeman, "Manufacturing Processes", John Wiley & Sons, (1987).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Complex Engineering Problems will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

VI HUM 316 Critical Thinking and Reasoning

- **Title:** Critical Thinking and Reasoning
- **Code Number:** HUM 316
- **Semester:** 5th
- **Credit hours:** 2 (2, 0)
- **Pre-requisites course:** English
- **Learning Outcomes:**

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

1. Analyze the basic concepts of Logic & critical thinking including proposition, arguments, truth, validity soundness and disagreements and controversies.
2. Explain the uses of languages and identify the fallacies of ambiguity, presumption and irrelevance.
3. To critically analyze and present any relevant issue in a logical manner.

Course Outline

Unit-1: The Power of Critical Thinking

1.1 Claims and Reasons
1.2 Reasons and Arguments
1.3 Arguments in the Rough
1.4 The Environment of Critical Thinking
1.5 Perils of Haunted Mind, Self and the Power of the Group
1.6 Subjective and Social Relativism, Scepticism
1.7 Making Sense of Arguments; Arguments Basics, Patterns, Diagramming Arguments, Assessing Long Arguments

Unit-2: Reasons for Belief and Doubt

2.1 Conflict Experts and Evidence
2.2 Personal Experience, Fooling ourselves
2.3 Claims in the News
2.4 Faulty Reasoning
2.5 Irrelevant Premises
2.6 Genetic Fallacy, Composition, Division
2.7 Appeal to the Person, Equivocation
2.8 Appeal to Popularity
2.9 Appeal to Tradition
2.10 Appeal to Ignorance, Appeal to Emotion,
2.11 Red Herring, Straw Man, Unacceptable Premises
2.12 Begging the Question
2.13 False Dilemma, Slippery Slope
2.14 Hasty Generalization, Faulty Analogy
2.15 Deductive Reasoning: Propositional Logic, Connectives and Truth Values
2.16 Conjunction, Disjunction, Negation, Conditional, Checking for Validity
2.17 Simple Arguments, Tricky Arguments
2.18 Streamlined Evaluation, Deductive Reasoning: Categorical Logic, Statements and Classes

2.19 Translations and Standard Form, Terms, Quantifiers
2.20 Diagramming Categorical Statements
2.21 Sizing up Categorical Syllogisms
2.22 Inductive Reasons
2.23 Enumerative Induction, Sample Size
2.24 Representativeness
2.25 Opinion Polls
2.26 Analogical Induction
2.27 Casual Arguments
2.28 Testing for Causes
2.29 Casual Confusions

Unit-3: Inference

3.1 Inference to the Best Explanation
3.2 Explanations and Inference
3.3 Theories and Consistency
3.4 Theories and Criteria
3.5 Testability
3.6 Fruitfulness, Scope
3.7 Simplicity
3.8 Conservatism Judging Scientific Theories
3.9 Science and Not Science
3.10 The Scientific method
3.11 Testing Scientific Theories
3.12 Judging Scientific Theories
3.13 Copernicus versus Ptolemy
3.14 Evolution Versus Creationism
3.15 Science and Weird Theories
3.16 Making Weird Mistakes, Leaping to the Weirdest Theory
3.17 Mixing What Seems with What is
3.18 Misunderstanding the Possibilities
3.19 Judging Weird Theories
3.20 Crop Circles
3.21 Talking with the Dead

Recommended Books

1. V. Lewis, "The Power of Critical Thinking", Oxford University Press (2012).
2. R. Greg., "Logic: An Introduction", Routledge (2005).
3. P. W. David, C. Jerry, "Critical Reasoning", Wadsworth (2000).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation (min. 2) will be submitted before the written exam of final term
Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

VII HUM 328 The Holy Quran Translation

- **Title:** The Holy Quran Translation
- **Code Number:** HUM 328
- **Semester:** 2nd
- **Credit Hour:** 1 per week
- **Pre-requisites course requirements/ skills:** -
- **Learning Outcomes:**

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

1. Understand the translation and explanation of the Holy Quran
2. Demonstrate and practice the way of life in the light of teachings of Holy Quran

Course Outline

The students will learn Holy Quran with translation in this module. The course outline will be as approved by Academic Council of University of the Punjab.

Sixth Semester

I MME 321 Corrosion Engineering

- **Title:** Corrosion Engineering
- **Code Number:** MME 321
- **Semester:** 6th
- **Credit hours:** 3 (3, 1)
- **Pre-requisites course:** Applied Chemistry, Materials Thermodynamics and Kinetics
- **Learning Outcomes:**

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

1. Compare/classify various type of corrosion
2. Apply basic thermodynamic knowledge to estimate/ predict the corrosion process and rate under various circumstances
3. Analyze the effects of passivity and polarization on corrosion behavior of metals using their passivity and polarization curves and data
4. Suggest and apply the most suitable corrosion protection techniques and correct combination of alloys, design and operation conditions keeping consideration to sustainable environment

Course Outline

Unit-1: Corrosion Science

1.1 Destruction
1.2 Types of Destruction
1.3 Basics of Corrosion
1.4 Corrosion and environment
1.5 Theory of aqueous corrosion

Unit-2: Thermodynamics of corrosion

2.1 Corrosion reactions and rate expressions
2.2 Evaluation of materials corrosion resistance in terms of corrosion rate
2.3 Chemical, Electrical and Electrochemical potential
2.4 Electrochemical Cell, Single electrodes and Helmholtz Double layer
2.5 Electrode Potentials
2.6 Nernst Equation
2.7 Calculation of standard potentials
2.8 Measurement of standard electrode potential, EMF series, Galvanic series
2.9 Calculation of Reduction Potential of single electrode
2.10 pH and Hydrogen ion activity
2.11 Electrochemical mechanism of corrosion
2.12 Types of Corrosion Cells/Galvanic cells
2.13 Faradays Law and their application in determination of Corrosion rate
2.14 Factors Influencing Corrosion

Unit-3: Classification of Corrosion and their remedies

Unit-4: Pourbaix Diagrams

Unit-5: Polarization

5.1 Factors on which Polarization and Depolarization depends
5.2 Thermodynamic irreversibility and polarization
5.3 Corrosion kinetics
5.4 Potentiostatic and potentiodynamic measurements
5.5 Galvanostatic behavior of metals
5.6 Tafel equation, Bulter -Volmer Equation, Wagner-Traud Diagrams
5.7 Mixed Potential Theory
5.8 Passivity
5.9 Electrochemical Impedance Spectroscopy (EIS), Nyquist and Bode plots,
5.10 Three electrode corrosion cell
5.11 Influence of polarization on corrosion rate

Unit-6: Corrosion Prevention

7.1 Corrosion prevention techniques
7.2 Mechanism of Cathodic Protection
7.3 Types of Cathodic Protection
7.4 Design of Cathodic Protection
7.5 NACE Criteria
7.6 Types of Anodic Protection
7.7 Components of Anodic Protection System
7.8 Inhibitors
7.9 Corrosion control by environmental change
7.10 Corrosion control by coatings

Lab Outline: Practical pertinent to above mentioned contents.

Recommended Books

1. D. E.J. Talbot, J. D.R. Talbot, "Corrosion Science and Technology", CRC Press- Technology & Engineering (2018).
2. I. H. Khan, "Corrosion Technology", Vol-I, AFAQ Publications, 2nd Edition (2010).
3. P. R. Roberge, "Corrosion Engineering, Principles and Practice", McGraw-Hill Companies, Inc., (2008)
4. H. H. Uhlig ; R. Winston Revie, "Corrosion and Corrosion Control", John Wiley & Sons, 4th Edition (2008).
5. Z. Ahmad, "Principles of Corrosion Engineering and Corrosion Control", Elsevier Science & Technology Books (2006).
6. M. G. Fontana, "Corrosion Engineering", Tata McGraw-Hill (2006).
7. D. Stephen Cramer and S. Bernard Covino, ASM Handbook Volume 13 "Corrosion", ASM International (2005)
8. K. R. Trethewey, "Corrosion for Science & Engineering", Addison Wesley Longman (1996).

Teaching-learning Strategies

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Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation / Open Ended Lab / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

II MME 322 Welding and Joining Processes

- **Title:** Welding and Joining Processes
- **Code Number:** MME 322
- **Semester:** 6th
- **Credit hours:** 3 (3, 1)
- **Pre-requisites course:** Physical Metallurgy
- **Learning Outcomes:**

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

1. Comprehend various metal joining processes of engineering materials.
2. Analyse metallurgical weldments to ensure quality.
3. Construct WPS and PQR for a given welding process.

Course Outline

Unit-1: Joining technology

1.1 Rules and challenges of Joining processes
1.2 Primary and secondary forces involve in joining processes
1.3 Joining Options (Mechanical, Chemical & Physical joining).

Unit-2: Mechanical Joining

2.1 Mechanical fastening
2.2 Integral attachment

Unit-3: Mathematical analysis of mechanical joints

3.1 Analysis of internal forces
3.2 Simple stress and shearing stress in different mechanically joined structures
3.3 Shear flow & flow deflection due to Shear
3.4 Axial and shearing deformation and their analysis (Relationship between Stress and Deformation)

3.5 Poisson's Ratio – Biaxial and triaxial deformations and their analysis.

Unit-4: Chemical Joining

4.1 Adhesive bonding
4.2 Solvent cementing and mortaring
4.3 Thermal spraying polymers

Unit-5: Hybrid Joining Processes

5.1 Rivet bonding
5.2 Weld bonding
5.3 Weld brazing
5.4 Physical Joining: Brazing. Soldering. Welding.

Unit-6: Soldering

6.1 Principles
6.2 Equipment
6.3 Fluxes
6.4 Filler metals
6.5 Automatic soldering systems
6.6 Soldering Al & Mg and their alloys

Unit-7: Brazing

9.1 Equipment
9.2 Copper and copper alloys brazing
9.3 Aluminium brazing.

Unit-8: Welding:

8.1 Classification of welding process by phase reaction (Liquid–solid /Solid- Solid interface reactions or processes)
8.2 Classification of welding by pressurized & Non-pressurized processes
8.3 Classification of welding process by energy source (Mechanical, Chemical & Electrical energy). Mathematical analysis of weld joints.
8.4 Mechanical Energy**:** Cold welding, Hot pressure welding, Forge welding, Roll welding, Friction & friction stir welding, Ultrasonic welding, Explosion welding, Deformation diffusion welding, Creep isostatic welding.
8.5 Chemical Energy: Pressure gas welding, Pressure thermite welding, Oxy-fuel gas welding, Transient Liquid Phase Bonding.
8.6 Electrical Energy**:** Arc Welding (power source and polarity). Stud arc–, Resistance spot–, Resistance seam–, Projection–, Upset–, Percussion–, Gas-Tungsten Arc–, Plasma Arc–, Carbon Arc–, Atomic Hydrogen–, Gas-Metal Arc–, Shielded-Metal Arc–, Flux-Cored Arc–, Submerged Arc–, Electrogas– and Electroslag Welding.

Unit-9: Joint designs

10.1 Design for an assembly
10.2 Joint types & their preparation
10.3 Welding symbols. Codes and Standards (AWS, ASME etc.)

Unit-10: Metallurgical Aspects

10.1 Metallurgical aspects of weldment including effect of heat on deformation (stress), microstructure and properties
10.2 Welding of dissimilar metals

10.3 Types of welding defects and imperfections. WPS and PQR.

Lab Outline: Practical training of few joining processes with special attention to weld joint inspection and mechanical testing. Technical lectures should also be given on inspection and testing in lab.

Recommended Books

1. K.Weman, "Welding processes handbook", 2nd Edition, Woodhead publishing (2011)
2. H. B. Cary and S. C. Helzer, "Modern Welding Technology", Prentice Hall (2004).
3. A. D. Althouse, C. H. Turnquist et.al, "Modern Welding", Goodheart Wilcox Company (2000).
4. A. Pytel, F. L. Singer, "Strength of Materials", Harper & Row Publishers, NY, USA.
5. K. Easterling, "Introduction to the Physical Metallurgy of Welding", Butterworth-Heinemann (2000)
6. J. F. Lancaster, "Metallurgy of Welding", William Andrew (1999).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Open Ended Lab / Complex Engineering (min. 2) will be submitted before the written exam of final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

III MME 323 Steel Manufacturing Processes

- **Title:** Steel Manufacturing Processes
- **Code Number:** MME 323
- **Semester:** 6th
- **Credit hours:** 3 (3, 0)
- **Pre-requisites course:** Iron Manufacturing Technology
- **Learning Outcomes:**

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

1. Explains various steel making processes.
2. Comprehend principles of steel manufacturing.
3. Analyze steel melting problems and defects.
4. Explain advanced ferrous alloys.

Course Outline

Unit-1: Introduction to Steel Making Processes

1.1 An introduction to historical and modern steel making processes
1.2 Puddling Process for Wrought Iron making
1.3 Cementation Process for Blister steel making
1.4 Crucible Process for carbon steel making
1.5 Layout of a steelmaking shop

Unit-2: Raw Materials for Contemporary Steel Making

2.1 Hot Iron from Blast Furnace, Pig Iron, Direct Reduced Iron. Hot Briquetted Iron,
2.2 Various types of steel scrap, Mill Scale, Fluxes, refiners and Ferro-alloys

Unit-3: Physical Chemistry of Steelmaking

3.1 Basis of Principal Reactions associated with a Steel Making Process
3.2 Oxidation, slag making, refining and Ferro-alloys addition
3.3 Vacuum treatment to the molten steel
3.4 Effect of alloying elements in steel

Unit-4: Modern Steel Making Processes

4.1 Birth of Modern Steel Making
4.2 Bessemer Converter Steel making Process
4.3 Open Hearth Steel Making Process, Basic Oxygen Process of Steel Making (Kaldo Process, LD Process, Rotor Process)
4.4 Electric Arc Steel Making
4.5 Induction Melting for steel Making
4.6 Vacuum Induction Melting for Ferrous Alloys Making

Unit-5: Secondary Steel Making Processes

6.1 Ladle Metallurgy
6.2 Gases and Non-Metallic Inclusions in molten Steels and their Removal
6.3 Vacuum application for degassing
6.4 Inert gas and Synthetic slag treatments for NMI expulsion, AOD, VOD Processes etc.

Unit-6: Solidification of Molten Steels

6.1 Ingot and Continuous casting for billets making, related defects

Unit-7: Furnace refractories

Unit-8: Introduction to Important Carbon and Alloy Steels

8.1 High Strength Low Alloys (HSLA), Stainless Steels, Duplex and super duplex stainless steels
8.2 Die and Tool Steels
8.3 Interstitial-Free and Ultra Low Carbon bainitic steels
8.4 Amorphous (BMG) Steel
8.5 Maraging Steels

Rec**ommended Books**

1. R. H. Tupkary, "An Introduction to Modern Steel Making", Khanna Publishers, 7th Edition, (2015).
2. A. K. Charabarti, “Steel Making”, PHI publishers, (2006).
3. J. J. Moore, “Chemical Metallurgy”, Butterworth-Heinemann, (1990).
4. V.A. Kadrin, “Steel Making”, Mir Publisher, 2nd Edition (1985).
5. C. Bodsworth, “Physical Chemistry of Iron and Steel Manufacture”, Prentice Hall, (1972)
6. R. H. Parker, "An Introduction to Chemical Metallurgy", Pergamon, (1967).
7. H. E. McGannon, "The Making, Shaping and Treating of Steel", United States Steel, (1964).
8. J. Newton, “Extractive Metallurgy”, John Wiley & Sons Inc, (1959).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Complex Engineering Problems (min. 2) will be submitted before the written exam of the final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

IV MME 314 Composite Materials

- **Title:** Composite Materials
- **Code Number:** MME 324
- **Semester:** 6th
- **Credit hours:** 2 (2, 0)
- **Pre-requisites course:** Polymeric Materials, Engg. Mechanics
- **Learning Outcomes:**

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

1. Comprehend types, properties and applications of composite materials.
2. Explain processing techniques of composite materials.
3. Predict properties of composite materials using principles of micromechanics.

Course Outline

Unit-1: Introduction to composite materials

1.1 Definition
1.2 Prerequisites for composites
1.3 Natural composites
1.4 Roles of matrix and dispersed phase
1.5 Properties of composite
1.6 Advantages and Disadvantages of Composites
1.7 Classification of composites
1.8 Fillers for composites (micro and nanofillers)
1.9 Dimensionality of fillers
1.10 Thermosetting resins and thermoplastic matrix for composite materials
1.11 Dispersion Strengthened Composites (Nanoparticle based Composites)
1.12 Effect of fillers on properties of composites
1.13 Particulate reinforced composites (cermets)
1.14 Applications of Composite Materials

Unit-2: Carbon nanomaterials

2.1 Production and properties of various carbon nanomaterials

Unit-3: Fibers reinforced Composites

3.1 Fibers for reinforcement
3.2 Functions of fibers
3.3 Influence of fiber length on properties of composites
3.4 Stress-position profiles for fibers
3.5 Classification of Fiber reinforced composites
3.6 Production and properties of various fibers used for production of composites (glass, Kevlar, carbon, boron)
3.7 Polymer matrix composites; glass, carbon and aramid fiber reinforced composites
3.8 Interfacial bonding in composites

Unit-4: Mechanics of Composites

4.1 Concept of mass and volume fraction and voids in composites
4.2 Mechanics of composites
4.3 Laminate theory

4.4 Failure modes of fiber reinforced composites
4.5 Strength of long fiber composites
4.6 Off-axis loading of lamina
4.7 Stiffness of laminates
4.8 Toughness of composites
4.9 Fatigue of composites

Unit-5: Matrix specific composites

5.1 Carbon matrix composites
5.2 Metal matrix composites
5.3 Ceramic matrix composites
5.4 Hybrid composites
5.5 Natural fiber-reinforced polymer composites
5.6 Sandwich composites
5.7 Laminates

Unit-6: Processing of composites

6.1 Hand layup process
6.2 Spray up process
6.3 Vacuum bag autoclave molding
6.4 Pressure bag molding
6.5 Autoclave molding
6.6 Pultrusion
6.7 Prepreg making
6.8 Filament winding
6.9 Compression molding
6.10 Injection molding
6.11 Resin tranfer molding

Unit-7: Inspection and Testing of Composites

Unit-8: Joining, Repair and Recycling of Composites

Recommended Books

1. K. Kamal, " Composite Materials: Processing, Applications and Characterization", Springer (2017).
2. W. D. Callister, "Materials Science and Engineering: An Introduction", John Wiley and Sons, Inc, 10th Edition (2018).
3. A. K. Kaw, "Mechanics of composite materials", CRC Press, 2nd Edition (2005).
4. S.T. Peter, "Handbook of composites" Chapman and Hill, (1998).
5. M.M. Schwartz, "Composite Materials Handbook", McGraw-Hill, 2nd Edition (1983).

Teaching-learning Strategies

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Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation / Complex Engineering Problems will be submitted before the written exam of the final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

VI CSC 326 Computational Materials Science

- **Title:** Computational Materials Science
- **Code Number:** CSC 326
- **Semester:** 6th
- **Credit hours:** 2
- **Pre-requisites course:** Mathematics -I and II, Computer Programming and Engg. Mechanics
- **Learning Outcomes:**

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

1. Apply knowledge of mathematics, science, and engineering to solve the problems of materials engineering.
2. Identify, formulate, and solve engineering problems, particularly in the context of materials selection and design.

Course Outline

Unit-1: Modelling

1.1 Introduction to modelling
1.2 Model development testing and verification
1.3 Fundamental conservation relationships
1.4 Boundary conditions

Unit-2: Computer modelling

2.1 Finite difference method (FDM)
2.2 Finite element method (FEM)
2.3 Mesh and mesh generation
2.4 Solution methods for linear systems
2.5 Storage matrices in memory

Unit-3: First-principle approaches

Unit-4: Molecular dynamics simulations
Unit-5: Monte-Carlo simulations in materials science and engineering
Unit-6: Stochastic methods for optimization.

Recommended Books

1. R. Lesar, "Introduction to Computational Materials Science: Fundamental to Applications", Cambridge University Press (2013).
2. D. Raabe, "Computational Materials Science: The simulation of Materials, Microstructures and Properties", Wiley (2007).

Teaching-learning Strategies
The teaching and learning strategies have been designed on the understanding of concepts and the ability to critically analyse and apply the learned content through lectures, discussion, activities, case studies using computer, multi-media and writing board instructional aids.

Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation /Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

V MME 326 Polymeric and Composite Materials

- **Title**: Polymeric and Composite Materials
- **Course Code**: MME 326
- **Credit Hours**: 1(0,1)
- **Lab Contact hours**: 3

Lab Outline: Practical pertinent to courses Polymer Science and Engineering and Composite Materials will be included in this lab.

Teaching-learning Strategies
The teaching and learning strategies have been designed on the understanding of concepts and the ability to critically analyse and apply the learned content through lectures, discussion, activities, case studies using computer, multi-media and writing board instructional aids.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

VII CSC 327 Computer Application in Materials Engineering

- **Title:** Computer Applications in Materials Engineering
- **Code Number:** CS 327
- **Semester:** 6th
- **Credit hours:** 0 (0, 1)
- **Lab contact hours:** 3
- **Pre-requisites course:** Computer Science and Information Technology
- **Learning Outcomes:**

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

1. Comprehend the use of modern softwares in Materials Engineering.
2. Apply modern software to solve engineering problems.

Lab Outline: Softwares such as SolidCast®, ThermoCalc®, ANSYS®, SIMHEAT® and other related softwares will be used to solve and simulate various Materials engineering problems and similar practical activity will be performed on above mentioned softwares.

Teaching-learning Strategies
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Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

Seventh Semester

I MME 411 Tribology and Surface Engineering

- **Title:** Tribology and Surface Engineering
- **Code Number:** MME 411
- **Semester:** 7th
- **Credit hours:** 4 (3, 1)
- **Pre-requisites course:** Corrosion Engineering
- **Learning Outcomes:**

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

1. Explain the mechanism of friction, wear, their remedies and lubrication.
2. Comprehend the various surface cleaning, roughening and hardening processes.
3. Select and Apply suitable processes of surface treatment for different applications.

Course Outline

Unit-1: Introduction to surface engineering and tribology

Unit-2: Friction

2.1 Types & prevention
2.2 Laws and basic mechanisms of sliding friction
2.3 Friction of different engineering materials

Unit-3: Wear

3.1 Introduction to wear
3.2 Types of wear mechanism
3.3 Types of particles in wear debris
3.4 Wear of different engineering materials
3.5 Wear prevention

Unit-4: Lubrication

5.1 Fluid Film Lubrication
5.2 Modes of lubrications (Hydrostatic, Hydrodynamic, Elasto-hydrodynamic, Mixed, Boundary & Solid-Film Lubrication)
5.3 Surface interactions with environment (Surface reconstruction, Segregation, Physisorption, Chemisorption, Compound formation)
5.4 Microstructural Effects on Wear and Friction
5.5 Wear and Galling Properties of Materials
5.6 Wear Behaviour of Solid Lubricants and Self-Lubricating Solids

Unit-5: Surface Treatment

5.1 Cleaning (Solvent cleaning, Emulsion cleaning Alkaline cleaning, Acid cleaning, Pickling, Salt Bath Descaling, Ultrasonic cleaning, Plasma cleaning)
5.2 Roughening (abrasive Blasting, Barrel Finishing, Mechanical Polishing and Buffering, Chemical Etching, electropolishing)

Unit-6: Coatings

6.1 Types of coatings (Metallic, Non-Metallic)
6.2 Functions of Coatings

6.3 Techniques of coating deposition (Spraying, Welding, cladding, Vapor deposition, chemical deposition, Electrochemical deposition, plating)
6.4 Coating systems for optical applications
6.5 Multi-layered coating architectures
6.6 Anti-reflection coatings
6.7 Wavelength selective coating design

Unit-7: Microstructural treatments on Surfaces

7.1 Induction hardening
7.2 LASER Hardening
7.3 Electron Beam hardening
7.4 Chill Casting
7.5 Work Hardening
7.6 Diffusion treatments (Overview of Carburizing, Carbonitriding, Nitriding, Nitro-carburizing, chromizing, Boriding, Aluminizing, Siliconizing, Sherardizing)

Unit-8: Implantation Treatment

8.1 Ion Implantation
8.2 Ion Beam Implantation
8.3 Green Surface Engineering & Green Tribology
8.4 Coatings for surgical and cutting tools, Bearing, Seals Gears, Piston Rings, Bushes, etc.
8.5 Tribological Components and Applications.

Lab Outline: Practical pertinent to above mentioned contents.

Recommended Books

1. R. Chattopadhyay, "Green Tribology, Green Surface Engineering, and Global Warming", ASM International (2014)
2. T. Mang, Kirsten et.al, "Industrial Tribology", WILEY-VCH Verlag & Co. KGaA, Germany (2011)
3. K. Holmberg & A. Matthews, "Coatings Tribology", Elsevier (2009)
4. J. Takadoum, "Materials and Surface Engineering in Tribology", John Wiley & Sons (2008)
5. S. Kalpakjian et.al, "Manufacturing Processes for Engineering Materials", Pearson Education (2003)
6. B. Bhushan, "Modern Tribology Handbook", CRC Press (2001).
7. J. B. Hudson, "Surface Engineering: An Introduction", Butterworth-Heinemann, (2000).
8. B. Bhushan, "Principles and Applications of Tribology", John Wiley & Sons (1999).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Open Ended Lab / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

II MME 412 Materials Characterization

- **Title:** Materials Characterization
- **Code Number:** MME 412
- **Semester:** 7th
- **Credit hours:** 3 (2, 1)
- **Theory Credit Hours:** 2 per week
- **Lab Credit Hours:** 1 per week
- **Lab Contact Hours:** 3 per week
- **Pre-requisites course:** Applied Physics, Applied Chemistry, Physical Metallurgy
- **Learning Outcomes:**

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

1. Comprehend types, properties and applications of x-rays.
2. Explain working principle, equipment and applications of various characterization techniques.
3. Analyse data of various characterization techniques.

Course Outline

Unit-1: X-rays

1.1 Properties and production of x-rays
1.2 Characteristic x-rays
1.3 Moseley's Law
1.4 Absorption of x-rays
1.5 Filters
1.6 Synchrotron radiation source
1.7 X-ray detectors
1.8 X-ray safety

Unit-2: Crystallography

2.1 Overview of lattice, planes, symmetry, directions, direction vectors, zone axis, etc.,
2.2 Reciprocal lattice

Unit-3: X-ray Diffraction

3.1 Bragg's law
3.2 Diffraction methods
3.3 X-ray diffraction
3.4 Ewald sphere
3.5 Debye-Scherrer technique
3.6 Powder diffraction
3.7 Indexing planes
3.8 Diffractometer
3.9 Experimental consideration during diffraction
3.10 Applications of x-ray diffraction (Scherrer equation, size and strain analysis),

Unit-4: Microscopic Techniques

4.1 Electron-matter interaction
4.2 Scanning electron microscopy
4.3 Transmission electron microscopy
4.4 Energy dispersive X-ray analysis
4.5 X-ray florescence spectroscopy
4.6 Atomic force Microscopy

Unit-5: Spectroscopy Techniques

5.1 Molecular vibrations and their types
5.2 UV-vis spectroscopy
5.3 FTIR-spectroscopy
5.4 Emission spectrometer

Unit-6: Thermal Analysis Techniques

6.1 TGA
6.2 DSC
6.3 DTA

Unit-7: Electrochemical characterization techniques (CV, GCD, LV,etc)

Lab Outline: Practical pertinent to above mentioned contents.

Recommended Books

1. Sharma et al., "Handbook of Materials Characterization", Springer (2018)
2. P. Campos et al., "Materials Characterization", Springer (2015).
3. B.D. Culty, "Elements of X-ray Diffraction", Prentice Hall, 3rd Edition (2002)
4. P. J. Goodhew and F. J. Humphreys, "Electron Microscopy and Analysis", Taylor & Francis (2001).
5. M. E. Brown, "Introduction to Thermal Analysis" Techniques and Applications, Kulwer Academic Publishers (2001)
6. J. B. Wachtman, "Characterisation of Materials", Butterworth- Heinemann (2000).
7. D. Brandon and W. D. Kaplan, "Microstructural Characterisation of Materials", Wiley (1999).
8. N.P. Cheremisinoff, "Polymer Characterization, Laboratory Techniques and Analysis", Noyes Publication, USA (1996)

Teaching-learning Strategies

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Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

III MME 413 Non-Ferrous Metallurgy

- **Title:** Non-Ferrous Metallurgy
- **Code Number:** MME 413
- **Semester:** 7th
- **Credit hours:** 2
- **Pre-requisites course:** Mineral Processing, Foundry Engineering-II, Materials Thermodynamics
- **Learning Outcomes:**

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

1. Explain the properties, sources and applications of various non-ferrous metals and alloys
2. Comprehend various extraction routes for the production of non-ferrous metals

Course Outline

Unit-1: Introduction

1.1 Introduction to Non-Ferrous Production Metallurgy
1.2 Importance and Demand of Non-Ferrous Metals
1.3 Composition of Earth Crust
1.4 Non-Ferrous Metals in Pakistan.

Unit-2: Aluminium

2.1 General Properties
2.2 Alloys, Applications, Sources, Extraction Route
2.3 Bayer's Process (for the Production of Alumina)

2.4 Hall-Heroult process
2.5 Electrolytic Refining of Al (Three layer process or Hope's process)
2.6 AlCOA process.

Unit-3: Copper

3.1 General Properties, Alloys, Applications, Sources, Extraction Route
3.2 Extraction of Copper from Sulphide Ores
3.3 Roasting
3.4 Multiple Hearth Roaster, Fluid-Bed Roaster
3.5 Smelting, Converting, Fire Refining of Blister Copper
3.6 Electrolytic Refining of Copper.

Unit-4: Titanium

4.1 General Properties, Alloys, Applications, Sources, Extraction Route
4.2 Production from Rutile ore, Chlorination of TiO_2
4.3 KROLL Process.

Unit-5: Magnesium

5.1 General Properties, Alloys, Applications, Sources, Extraction Route
5.2 Electrolytic Processes (Dehydration of Carnallite, Electrolysis of chlorides in fused condition),
5.2 Thermal Processes (The preparation of reducing agent and source materials; Reduction, sublimation and condensation of Mg vapour; Smelting of the condensed crystals into pigs).

Unit-6: Zinc

8.1 General Properties, Alloys, Applications, Sources, Extraction Route
8.2 Pyrometallurgical Extraction
8.3 Roasting of Zinc Concentrate
8.4 Flash Roasting, Fluid Bed Roasting
8.5 Multiple Hearth Roasting, Sintering
8.6 Smelting (Horizontal Retort, Vertical Retort, Electrothermic Furnace, Blast Furnace)
8.7 Fire Refining (Fractional Distillation, Zn Liquation).

Unit-7: Lead

7.1 General Properties, Alloys, Applications, Sources, Extraction Route
7.2 Roasting of Lead Concentrate, Smelting
7.3 Pyrometallurgical Refining of Lead Bullion (De-coppering, Removal of Tin, Arsenic and Antimony by oxidation, De-silverization and De-golding, De-zincing, De-bismuthizing, Removal of Magnesium and Calcium).

Unit-8: Gold

8.1 General Properties, Alloys, Applications, Sources, Extraction Route
8.2 Amalgamation, Cyanidation, Chlorination processes, Refining of Gold.

Unit- 9: Silver

9.1 General Properties, Alloys, Applications, Sources, Extraction Route
9.2 Chloridizing Roast
9.3 Extraction by Cyanidation
9.4 The Moebius Cell (Electrolytic Refining of Silver)
9.5 Park's Process.

Unit-10: Tin

10.1 General Properties, Alloys, Applications, Sources, Extraction Route

10.2 Reverberatory Furnace Smelting Process
10.3 Electrolytic Refining.

Unit-11: Nickel

11.1 General Properties, Alloys, Applications, Sources, Extraction Route
11.2 Pyrometallurgical Extraction of Nickel From Sulphide Ores, Roasting of Nickel Sulphide Concentrates
11.3 Smelting of Nickel Concentrate
11.4 Bessemerising (Converting) of Copper-nickel Matte, Nickel Carbonyl Process
11.5 The Mond Process of Nickel Refining.

Unit-12: Chromium

12.1 General Properties, Alloys, Applications, Sources, Extraction Route of Chromium.

Unit-13: Tungsten

13.1 General Properties, Alloys, Applications, Sources, Extraction Route
13.2 Roasting of Tungsten Concentrate
13.3 Precipitation of Tungstic Acid, Purification of Technical Tungstic Acid
13.4 Production of Tungsten Metal Powder
13.5 Manufacturing of Ductile Tungsten.

Unit-14: Zirconium

14.1 General Properties, Alloys, Applications, Sources, Extraction Route.

Recommended Books

1. A. Kamble, “A textbook of metallurgy : Properties and Applications of Ferrous and Non-Ferrous alloys” Harshal Publications (2017).
2. F.Cardarelli, “Materials Handbook”, Springer (2000).
3. J.J. Moore, “Chemical Metallurgy”, Butterworth-Heinemann (1990).
4. C. B. Gill, "Nonferrous Extractive Metallurgy", Krieger Pub Co. (1988).
5. H. S. Ray, R. Sridhar and K. P. Abraham, “Extraction of Non-Ferrous Metals”, Affiliated East-west Press (1987).
6. N. Sevryukov, B. Kuzmin and Y. Chelishchev, "General metallurgy", MIR Publishers (1969).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Complex Engineering Problems (min 2) will be submitted before the written exam of final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

IV – (Students can select any one of these elective) courses)

Elective-I-A MME 414A Biomaterials

- **Title:** Biomaterials
- **Code Number:** MME 4 14 A
- **Semester:** 7th
- **Credit hours:** 2
- **Pre-requisites course:** Polymer Science and Technology, Fundamentals of Metallurgy and Materials Engineering, Physical Metallurgy, Composite Materials
- **Learning Outcomes:**

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

1. Explain properties and applications of various materials used in biomedical applications.
2. Select suitable biomaterial for specific application.

Course Outline

Unit-1: Introduction to Biomaterials

1.1 Introduction and classification of Biomaterials
1.2 Properties of biomaterials
1.3 Biomaterials interaction with cells

Unit-2: Metallic Biomaterials

2.1 Bio-metallic materials (Ti and Ti alloys, Mg and Mg alloys, Ni-Ti shape memory materials, etc),

Unit-3: Biomaterials for Implants

3.1 Dental materials
3.2 Bone structure and properties
3.3 Bone replacement materials
3.4 Biomedical implants (materials for prosthesis, hip replacement, knee replacement, shoulder joint, ear implants, heart valve implants, stent materials), shape memory fabrics, sterilization of biomedical implants

Unit-4: Bio-ceramics
Unit-5: Biomaterials used in plastic surgery
Unit-6: Tissue engineering and Bio-machines
Unit-7: Biomaterials for Ophthalmic applications

Unit-8: Drug delivery systems

Recommended Books

1. H. Vasif et.al., "Fundamentals of Biomaterials, Springer-Verlag New York" ,3rd Edition (2018).
2. C. M. Agrawal, J. L. Ong, "Introduction to Biomaterials: Basic Theory with Engineering Applications", Cambridge Texts in Biomedical Engineering, Ist Edition (2014)
3. V. Migonney, "Biomaterials", Wiley, (2014)

Teaching-learning Strategies
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Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation (min. 2) will be submitted before the written exam of the final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

Elective-I-B MME 414B Nanomaterials and Nanotechnology

- **Title: Nanomaterials and Nanotechnology**
- **Code Number:** MME 414 B
- **Semester:** 7th
- **Credit hours:** 2
- **Pre-requisites course:** Fundamentals of Metallurgy and Materials Engineering, Applied Physics
- **Learning Outcomes:**

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

1. Explain properties, synthesis and applications of various nanomaterials.
2. Comprehend the suitability of a nanomaterials for specific applications.
3. Comprehend health and safety issues related to nanomaterials.

Course Outline

Unit-1: Introduction to Nanomaterials and Nanotechnology

1.1 Properties and applications of nanomaterials for engineering
1.2 Production techniques including top-down and bottom-up processes
1.3 Dimensionality of nanomaterials

Unit-2: Carbon Nanomaterials

2.1 Carbon nanotubes
2.2 Graphene, graphite nanoplatelets
2.3 Nanoclays

Unit-3: Nanotechnology

3.1 Role of Nanotechnology in various fields such as energy, environment, automobile, aerospace, etc.
3.2 Nanocomposites
3.3 Nanostructured materials
3.4 Nanoporous materials
3.5 Bio nanotechnology
3.6 Self-assembly
3.7 Functional nanomaterials

Unit-4: Nanomaterials handling, safety and precautions

Unit-5: Special characterization methods for nanomaterials

Recommended Books

1. M. Benelmekki, "Nanomaterials: The original product of nanotechnology", Morgan & Claypool Publisher (2019).
2. G. Cao and Y. Wang, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications", World Scientific (2011).
3. C. Koch, "Nanostructured materials: Processing, Properties and Applications", William Andrew, Inc., 2nd Edition (2007).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

V MSC 415 Industrial Quality Management

- **Title:** Industrial Quality Management
- **Code Number:** MSC 415
- **Semester:** 7th
- **Credit hours:** 3 (3, 0)
- **Pre-requisites course:** None
- **Learning Outcomes:**

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

1. Apply Quality Management principles and techniques to assess and improve organizational and business process efficiency and effectiveness.
2. Understand the concept of acceptance sampling and be familiar with different sampling plans
3. Understand the concept of reliability and risk management
4. Design and manage SQC in manufacturing sector
5. Make use of statistical methods and tools to improve process quality

Course Outline

Unit-1: Introduction and Evolution of Quality

1.1 Introduction to Quality Control
1.2 Quality Assurance
1.3 Total Quality Management and its evolution
1.4 Gurus of TQM and their ideas
1.5 Quality philosophies and approaches (e.g., Juran, Denting, Taguchi, Ishikawa)
1.6 Cost of quality

Unit-2: Controlling and Assuring Product and Process Quality

2.1 Acceptance sampling (Single and Double Sampling Plans etc.)
2.2 Measurement systems Analysis (Repeatability & Reproducibility)

Unit-3: Problem Solving and Quality Improvement

3.1 Techniques for continuous quality improvement
3.2 Seven Quality tools, Kaizen, Lean Six sigma, Balance score card, brainstorming
3.3 6Cs of TQM and implementation
3.4 Japanese Quality practices (5S)
3.5 Time and motion study
3.6 Value Stream Mapping
3.7 Statistical Process Control (SPC)
3.8 Analysing Process Capability

Unit-4: Inspection and Testing for Quality Control

4.1 Role of Inspection and testing for Quality Control
4.2 Fundamental concept of inspection
4.3 Types of Inspection
4.4 General principles of measurement
4.5 Frequency of Inspection and testing
4.6 Stages of Inspection and testing techniques during manufacturing.
4.7 Creating Inspection report

4.8 Development of KPI's
4.9 Instruments and equipment used for inspection
4.10 Calibration of equipment, frequency of calibration. ISO 17025:2017.

Unit-5: Reliability and risk management

6.1 Reliability life characteristic concepts
6.2 Design of systems for reliability
6.3 Reliability and maintainability
6.4 Reliability failure analysis and reporting
6.5 Reliability safety, hazard and assessment tools

Recommended Books

1. N. R. Tague, "The Quality Toolbox", ASQ, 2nd Edition (2015)
2. D. H. Besterfield, "Quality Control", Pearson Education, 8th Edition (2009)
3. T. Pyzdek, P.A. Keller, "Quality Engineering Handbook", CRC Press (2009).
4. S. Lawrence, "Fundamentals of Industrial Quality Control", CRC Press (2009)
5. D.H. Stamatis, "TQM Engineering Handbook", CRC Press (2009).
6. J. S. Oakland, "Total Quality Management with text cases", Butterworth-Heinemann, 3rd Edition (2003).
7. W. William, "Inspection and measurement in manufacturing", Society of manufacturing Engineers (1995).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

VI MME 416 Design Project-I

- **Title:** Design Project-1
- **Code Number:** MME 416
- **Semester:** 7th
- **Credit hours:** 3

Group of students will work on design project of industrial scope and importance under the supervision of faculty members. The duration of the project will be two semesters (7th and 8th semester). The students will complete data collection regarding the project, development of design of experiments, development of flow sheet, material selection, and cost estimation. The progress will be monitored through interim presentations and reports. Finally, written thesis will be required, duly approved by the supervisor.

Eighth Semester

I MME 421 Powder Metallurgy

- **Title:** Powder Metallurgy
- **Code Number:** MME 421
- **Semester:** 8th
- **Credit hours:** 2
- **Pre-requisites course:** Manufacturing processes, Physical Metallurgy
- **Learning Outcomes:**

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

1. Comprehend the basic knowledge of Powder Metallurgy processing.
2. Evaluate the complex sintering process and select proper parameters and furnace to successfully produce a powder metallurgy part
3. Apply the theoretical knowledge to solve the problems related to the material applications

Course Outline

Unit-1: Introduction to powder metallurgy
Unit-2: Production of Powders

1.1 Commercial methods for production of metal powders
1.2 Powder characterization and testing,
1.3 Powder conditioning and function of addition agents
1.4 Consolidation of metal powders
1.5 Cold Isostatic Compacting
1.6 Hot Isostatic Compacting
1.7 Dies for powder compaction,

Unit-3: Powder Processing Methods

3.1 Powder Rolling
3.2 Powder Forging
3.3 Powder Extrusion
3.4 Powder Injection Moulding
3.5 Spray Forming.

Unit-4: Sintering

7.1 Theory of Sintering
7.2 Sintering Practices
7.3 Sintering Atmospheres
7.4 Sintering Furnaces

Unit-5: Powder Metallurgy of Refractory and Reactive Metals
Unit-6: Powder metallurgy of Super Alloys
Unit-7: Dispersion-strengthened materials
Unit-8: Secondary operations performed on powder metallurgical parts and products
Unit-9: Inspection and Quality Control for powder metallurgical materials and parts

Recommended Books

1. P.S. Gill, "Principles of Powder Metallurgy", S.K.Kataria Publishers (2015).
2. A. Upadhaya, "Powder Metallurgy: Science, Technology and Materials", Universities Press 1st Edition (2011).
3. R. M. German, "A - Z of Powder Metallurgy", Elsevier Science (2006).
4. W. G. West and L. F. Pease, "Fundamentals of Powder Metallurgy", Metal Powder Industries Federation (2002).
5. R. M. German, "Sintering Theory and Practice", Metal Powder Industries Federation (1996).
6. A. J. Yule and J. D. Dunkley, "Atomization of Melts for Powder Production and Spray Deposition", Clarendon Press (1994).
7. I. H. Khan book, K. A. Qureshi et.al, "Fundamentals of Powder Metallurgy", Institute of Chemical Engineering and Technology, University of the Punjab, Lahore, Pakistan (1988)
8. R. M. German, "Powder Metallurgy Science", Metal Powder Industries Federation (1984).
9. G. H. Gessinger, "Powder Metallurgy of Super alloys", Butterworth-Heinemann (1984).

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

II – (Students can select any one of the following elective courses)

Elective-II-A MME 422A Advanced Metallic Materials

- **Title:** Advanced Metallic Materials
- **Code Number:** MME 422 A
- **Semester:** 8th
- **Credit hours:** 2
- **Pre-requisites course:** Physical Metallurgy
- Upon successful completion of the course, the students will be able to:
    1. Comprehend types, properties and applications of superalloys, stainless steel, titanium alloys, etc.
    2. Comprehend the suitability of an appropriate material for a particular application.

Course Outline

Unit-1: Introduction

1.1 Properties and applications of superalloys
1.2 Types of superalloys (nickel, cobalt and iron-based superalloys)
1.3 Microstructure of superalloys
1.4 Phase diagrams

Unit-2: Strengthening mechanism
Unit-3: Manufacturing and heat treatment of superalloys
Unit-4: Stainless steels and Special steels
Unit-5: Zr alloys, refractory metals and alloys
Unit-6: Titanium alloys
Unit-7: ODS alloys, Mechanically alloyed metals, BMG, functionally graded metals, High entropy alloys.

Recommended Books

1. R. E. Smallman, A. H. W. Ngan, "Modern Physical Metallurgy", Elsevier, 8th Edition (2014).
2. R.C. Reed, "The Superalloys Fundamentals and Applications", Cambridge University Press (2006).
3. E. C. Leyens, M. Peters, "Titanium and Titanium Alloys. Fundamentals and Applications", Wiley (2003).
4. M. J. Donachie, "Superalloys: A Technical Guide", ASM International (2002).

Teaching-learning Strategies

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Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation / Complex Engineering Problems (min. 2) will be submitted before the written exam of the final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

Elective-II-B MME 422B Advanced Fabrication Processes

- **Title:** Advanced Fabrication Processes
- **Code Number:** MME 422 B
- **Semester:** 8th
- **Credit hours:** 2
- **Pre-requisites course:** Manufacturing Processes, Welding and Joining Processes
- **Learning outcomes:**
  Upon successful completion of the course, the students will be able to:
  1. Comprehend various codes and standards used in fabrication industry.
  2. Apply knowledge in various Industrial applications as per BE EN ISO, ASME, ASTM, AWS standards.
  3. Construct WPS and PQR for a given welding process.
  4. Comprehend and interpret different weld fabrication symbols as per BE EN and AWS standards.
  5. Perform non-destructive tests on weldments.
  6. Manage and provide cost effective solutions related to weld application.

Course Outline

Unit-1: Advanced Welding Technology

1.1 Introduction to advance welding technology
1.2 Introduction to auto welding, semi-auto welding/Orbital welding processes
1.3 Electrical parameters and their effect on metallurgical changes in materials
1.4 Calibration/validation of Welding Machines
1.5 Welding Production and cost effectives solution
1.6 Characteristics of auto welding machines, wire feeders, shielding gases and related important factors

1.7 Industrial applications e.g. welding spiral and seam pipelines, storage tanks cladding application and pressure vessels plates welding.

Unit-2: Welding Project Management

2.1 CPA (Critical Path Analysis)
2.2 Consumables Controls
2.3 Welding Documents Management
2.4 QA documents/ITP/QC Activities
2.5 Plan of inspections required documents to sign off packages
2.6 Consumables control
2.7 Duties as QC-welder and documentation control to achieve weld quality

Unit-3: Different Code and standards

3.1 ASME section IX / API 1104 / AWS introduction
3.2 Weld procedure qualification (WPS),
3.3 Procedure qualification report (PQR). Flow chart
3.4 Essential welding variables
3.5 Non-essential and supplementary essential variables.

Unit-4: Fabrication Drawings and Welding Symbols

4.1 Basic welding symbols on IFC and fabrication drawings

Unit-5: Advance Non-Destructive Testing

6.6 PAUT (Phased Array Ultrasonic Testing)
6.7 TOFD (Time of Flight Diffraction)
6.8 Advance Ultrasonic testing
6.9 Digital & Isotopic Radiographic Testing
6.10 Dye Penetrant Testing and Magnetic Particle testing
6.11 Introduction to advance NDT methods and their Comparisons and industrial uses

Unit-6: Material Weldability

6.1 Carbon Equivalent Value. Steel Family and weldability.
6.2 Types of Cracks (Hydrogen induced Cold cracking).
6.3 Solidification Crack.
6.4 Lamellar tearing.
6.5 Weld Decay/Grains Sensitization.
6.6 Re-heat cracking
6.7 Heat treatments of material and Weld joints
6.8 Residual Stress and Distortion
6.9 Welding Terminologies.

Recommended Books

1. K.S. Yadav, “Advanced Welding Technology”, Standard book house publishers (2018).
2. N. Bhatangar et al., “Processing and Fabrication of Advanced Materials”, Vol. 1 & 2, IK international publishing house (2008).
3. H. B. Cary and S. C. Helzer, "Modern Welding Technology", Prentice Hall, (2004).
4. A. D. Althouse, C. H. Turnquist and William A. Bowditch, "Modern Welding", Goodheart Wilcox Company, (2000).
5. J. F. Lancaster, “Metallurgy of Welding”, William Andrew, (1999)

Teaching-learning Strategies
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Assignments- Types and Number with calendar
Assignments / Quizzes / Presentation / Complex Engineering Problems (min. 2) will be submitted before the written exam of final term

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: classroom participation, attendance, class presentations and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

III MSC 423 Production and Operations Management

- **Title:** Production and Operations Management
- **Code Number:** MSC 423
- **Semester:** 8th
- **Credit hours:** 3
- **Pre-requisites course:** Industrial Quality Management
- **Learning Outcomes:**

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

1. Describe the role of operations management towards the achievement of an organizational objectives.
2. Comprehend the operational functions in manufacturing and services.
3. Identify operational issues with short, intermediate and long lead times.
4. Examine different approaches for problem solving and process improvement in production systems.

Course Outline

Unit-1: Management Science

1.1 Principles of Managements
1.2 Introduction and Evolution of Management Science
1.3 Management Levels
1.4 Managing with Competitive advantage

Unit-2: Organization Structure

2.1 Organizational structure
2.2 Concept of Holacracy
2.3 Managers and managerial skills
2.4 Functions of Management, Planning, Organizing, Leading, Controlling
2.5 Organizational Design
2.6 Culture and Environment, Power and leadership
2.7 Groups and teams.
2.8 Type of leadership, Types of Leaders, Sources of Power, Motivation and Criticism

Unit-3: Managerial Projects

5.1 Types of managerial projects
5.2 Role of project manager
5.3 Delegating authorities, tendering
5.4 Development of a Work Breakdown Structure (WBS).
5.5 Production Planning and Control.

Unit-4: Companies

4.1 Kinds of companies
4.2 Public and private companies, Company limited, Unlimited company

Unit-5: Plant Location

5.1 Plant Location: Needs objectives.
5.2 Factors influencing plant location strategies
5.3 Global location, models for plant location

Unit-6: Operation Management

6.1 Nature and Scope of Operation Management
6.2 Introduction to production/operation management functions and classification of production systems.
6.3 Policies and objectives, Strategies, Mission, Goal, Decision Making.
6.4 Forecasting; Types, Techniques, Time Span, Accuracy, Integer Programming.
6.5 Breakeven Analysis and Capacity Planning; Linear and non-linear.
6.6 Consumer and producer goods; Measures of economic worth
6.7 Price, Supply, & Demand relationship
6.8 Production; Manufacturing lead time
6.9 Production rate; Capacity; Utilization; Availability
6.10 Work in process; WIP and TIP ratios.
6.11 Maintenance: Cost for maintenance & repairs, proactive & active maintenance
6.12 Project Management; PERT, CPM

Recommended Books

1. S. P. Robbins, Mary Coulter, "Management", Pearson, 14th Edition (2018).
2. S. P. Robbins, Timothy A. Judge, "Organizational Behaviour", Pearson, 17th Edition (2016).
3. J. X. Warg, "What Every Engineer should Know about Business Communication", CRC Press (2008).
4. N. J. Aquilano, R. B. Chase, "Production and Operation Management", Irwin (2007).
5. W. G. Harcourt, "Production and Operation Management", Brace & World (2006).
6. E. S. Buffa, "Modern Production/Operations Management", C. B. S Publications (2003).
7. W. J. Stevenson, "Production/Operations Management ", McGraw-Hill (1990).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

Assignments / Quizzes / Presentation (min. 2) will be submitted before the written exam of the final term.

Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
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3.	Final Assessment	40%	Written examination at the end of semester.

IV MSC 424 Entrepreneurship

- **Title:** Entrepreneurship
- **Code Number:** MSC 424
- **Semester:** 8th
- **Credit hours:** 2
- **Pre-requisites course:** NA
- **Learning Outcomes:**

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

1. Comprehend the terminology and concepts of Entrepreneurship
2. Innovate the ideas necessary for a start-up
3. Prepare a successful business plan and a feasibility analysis

Course Outline

Unit-1: Exploring Entrepreneurship

1.1 Exploring Entrepreneurship, entrepreneur's risk and rewards,
1.2 Key characteristics of an entrepreneur, value of entrepreneurship
1.3 Entrepreneur Role in Society
1.4 Preparation for Entrepreneurship and Business, Types of Business and Ownership,
1.5 Importance of global economy and the effects on the production of their product/service
1.6 Identify factors the rewards and risks entrepreneurs may experience in local and international trade, Define liability and its legal obligation from entrepreneurs
1.7 Types of business ownerships.

Unit-2: Business Plan and Market Analysis

2.1 Opportunity Recognition and Market Analysis
2.2 Business plan, Types of business plan, Parts of a business plan
2.3 Putting together a business plan
2.4 Ways to recognize business opportunities
2.5 Use of creative thinking to generate ideas
2.6 Comparison of various types of business opportunities
2.7 Methods used to evaluate business opportunities, Market research
2.8 Targeting a market, Identifying competitors.
2.9 Business Plan Design, Business plan models
2.10 Similarities and differences between business plans
2.11 Describe SWOT (strengths, weaknesses, opportunities, threats) as it relates to a business

Unit-3: Entrepreneurship Organization

3.1 Entrepreneurship Organization
3.2 Marketing plans and sales
3.3 Analyzing and generating finances
3.4 Business start-up
3.5 Teamwork, Networking organization, Motivation and compensation, Value system,
3.6 Entrepreneurship and SMES; Defining SMEs and Scope of SMEs, Entrepreneurial managers of SME, Financial and marketing problems of SMEs,
3.7 Entrepreneurial Marketing; Framework for developing entrepreneurial marketing, Devising entrepreneurial marketing plan, Entrepreneurial marketing strategies;
3.8 Product quality and design

Unit-4: Entrepreneurship and Economic Development

4.1 Role of entrepreneur in the economic development generation of services
4.2 Employment creation and training, Ideas, knowledge and skill development
4.3 The Japanese experience
4.4 Case Studies of Successful Entrepreneurs, Entrepreneurship for Engineers

Recommended Books

1. Bruce. R. Barringer, R. Duane Ireland, "Entrepreneurship – Successfully Launching New Ventures", 4th Ed., Pearson (2012).

2. S. Read, S. Sarasvathy, N. Dew, R. Viltbank, "Effectual Entrepreneurship", Routledge, 2nd Edition (2011).
3. K. Uchino, "Entrepreneurship for Engineers", Taylor & Francis (2010).
4. W. Naude, "Entrepreneurship and Economic Development", Palgrave Macmillan (2010).
5. P.F. Drucker, "Innovation and Entrepreneurship", Routledge (2007).
6. P. Burns, "Small Business and Entrepreneurship", Palgrave, 8th Edition (2001).
7. J.B. Miner, "4 Routes to Entrepreneurial Success", Berrett Koehler (1996).

Teaching-learning Strategies

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Assignments- Types and Number with calendar

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Assessment and Examinations

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written or MCQ-based* examination at the mid-point of the semester.
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3.	Final Assessment	40%	Written examination at the end of semester.

V HUM 425 Industrial Psychology and Sociology

- **Title:** Industrial Psychology and Sociology
- **Code Number:** HUM 425
- **Semester:** 8th
- **Credit hours:** 2
- **Pre-requisites course:**
- **Learning Outcomes:**

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

1. Comprehend the structure of society, personality of the person and socialization procedure.
2. Apply the knowledge of sociology, psychology and tolerance to improve quality of workplace and organization.

Course Outline

Unit-1: Industrial Sociology, Sociology and Social Sciences

1.1 What is Industrial Sociology
1.2 Sociological Perspectives
1.3 Debunking in Industrial Sociology
1.4 Key Industrial Sociological Concepts
1.5 Role of Diversity in Industrial Sociology
1.6 Global Perspective
1.7 Scope and Importance of Industrial Sociology
1.8 Nature of Industrial Sociology
1.9 What does the Study of Industrial Sociology Necessitate?
1.10 Place of Industrial Sociology among the Social Sciences
1.11 Industrial Sociology and Occupational Skills

Unit-2: Social Groups in Industry

2.1 Socializing within an Organization
2.2 Patterned Social Behavior
2.3 What is a Group?
2.4 Functions of a Group
2.5 Group Development
2.6 Key Dimensions of a Group
2.7 Conformity
2.8 Social Loafing
2.9 Group Think
2.10 Committees in Industry
2.11 Focus Group
2.12 Teams

Unit-3: Theories and Movements: Industrial Sociological Perspectives

3.1 Gender Praise Addiction
3.2 Functionalism
3.3 Durkheim: The Dominant Tradition—Human Relation
3.4 Contingency Theory
3.5 Action Theory
3.6 Conflict Theory
3.7 Weber—Social Action Strand
3.8 Symbolic Interactionist
3.9 Theory of ‘Modernity’ and ‘Modernization’
3.10 Critical Theory, Postmodernism and Post-structuralism

Unit-4: Ethics and Human Values

4.1 Changes in Society and their Impact on Human Values
4.2 Ethics and Values
4.3 Policy Demands
4.4 Organizational Values
4.5 Trust
4.6 Personal Morality and Ethical Behavior
4.7 Societal Values
4.8 Applying Ethics in Industry
4.9 Basic Elements of an Ethical Organization
4.10 Whistle-Blowing
4.11 International Business Ethics
4.12 Diversity
4.13 Understanding New Accountabilities
4.14 Corruption

Unit-5: Industrial Psychology

5.1 What Is Industrial and Organizational Psychology?
5.2 The Importance of I-O Psychology
5.3 The Importance of Work in People's Lives
5.4 The Concept of "Good Work"
5.5 Authenticity:
5.6 A Trend of Interest to I-O Psychologists
5.7 How Does I-O Psychology Contribute to Society?
5.8 What Is I-O Psychology?
5.9 Evidence-Based I-O Psychology
5.10 SIOP as a Resource
5.11 The Importance of Understanding the Younger Worker

Unit-6-: Individual Differences and Assessment

6.1 An Introduction to Individual Differences
6.2 Some Background
6.3 Differential Psychology, Psychometrics, and I-O Psychology
6.4 Identifying Individual Differences
6.5 Varieties of Individual Differences

Unit-7: Human Attributes

7.1 Abilities
7.2 Cognitive Abilities
7.3 Intelligence as "g"
7.4 Is "g" Important at Work?

7.5 Is “g” as Important in Other Countries as It Is in the United States?
7.6 Can Your Level of “g” Change?
7.7 Specific Cognitive Abilities beyond “g”
7.8 Physical, Sensory, and Psychomotor Abilities
7.9 Personality and Work Behavior
7.10 The Big Five and Other Models of Personality
7.11 Additional Attributes

Unit-7: Job Analysis and Evaluation

9.1 Job Analysis
9.2 Importance of Job Analysis
9.3 Writing a Good Job Description
9.4 Employment Profile
9.5 Preparing for a Job Analysis
9.6 Conducting a Job Analysis
9.7 Using Other Job Analysis Methods
9.8 Evaluation of Methods

Uni-8: Job Evaluation

8.1 Determining Internal Pay Equity
8.2 Determining External Pay Equity
8.3 Sex and Race Equity
8.4 Career Workshop
8.5 Negotiating Salary On the Job: Applied Case Study: National Board of Veterinary Medical Examiners
8.6 Focus on Ethics: Compensating CEOs and Executives

Unit-9: Corruption and Anti-Corruption

9.1 What is corruption and anti-corruption?
9.2 Corruption and good governance, corruption and human rights
9.3 Citizen participation in anti-corruption

Recommended Books

1. R.T. Schaefer, B. Haaland, Sociology, McGraw Hill, 5th Edition (2014).
2. A. Giddens, Sociology, Cambridge Polity, 4th Edition (2004).
3. J. Tiffin, E. J. McCormick and D. R. Igen, "Industrial Psychology", Prentice Hall (1980).

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VI MME 426 Design Project-II

- **Title:** Design Project-II
- **Code Number:** MME 426
- **Semester:** 8th
- **Credit hours:** 3

Students will continue work on the Design Project Part-I. They will perform experiment on previously designed for the development or modification of materials. Perform characterization of materials using conventional and modern tools. Also students will analyse and interpret data. The modelling and simulation may be carried out, if desired for the project. The progress will be monitored through interim presentations and report. A final report in the form of project thesis will be submitted in approved format at the end of term.

VII HUM 427 The Holy Quran Translation

- **Title:** The Holy Quran Translation
- **Code Number:** HUM 316
- **Semester:** 2nd
- **Credit Hour:** 1 per week
- **Pre-requisites course requirements/ skills:** -
- **Learning Outcomes:**

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

1. Comprehend the translation and explanation of the Holy Quran
2. Demonstrate and practice the way of life in the light of teachings of Holy Quran

Course Outline

The students will learn Holy Quran with translation in this module. The course outline will be as approved by Academic Council of University of the Punjab.