OUTLINE OF COURSES

For

B. Sc. (Engg.) Chemical Engineering

(Semester System)

From 2020 onward

Institute of Chemical Engineering & Technology

Faculty of Engineering & Technology

University of the Punjab, Lahore

September 2020

Outline of Syllabi & Courses of Reading for Undergraduate Programs

1. B.Sc. (Engg.) Chemical Engineering

2. B.Sc. (Engg.) Chemical Engineering
with specialization in Petroleum & Gas Technology

I[st] Semester

Paper	Course Code	Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	CHE111	Chemical Process Industries-I	3	0	3
II	MTH112	Engineering Mathematics-I	2	0	2
III	NEN113	Functional English	2	0	2
IV	HUM114	Islamic Studies/Ethics*	2	0	2
V	PHY115	Applied Physics	3	0	3
VI	CHEM116	Applied Chemistry	3	0	3
VII	GEC117	Engineering Drawing Lab	0	3	1
VIII	PHY118	Applied Physics Lab	0	3	1
IX	CHEM119	Applied Chemistry Lab	0	3	1
X	HUM100	Quranic Translation	1	0	0
		Total:	15	9	18

2[nd] Semester

Paper	Course Code	Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	CHE121	Chemical Process Industries-II	3	0	3
II	CHE122	Chemical Engineering Principles-I	3	0	3
III	MTH123	Engineering Mathematics-II	3	0	3
IV	GEC124	General Engineering	2	0	2
V	CHEM125	Physical Chemistry	3	0	3
VI	CHEM126	Physical Chemistry Lab	0	3	1
VII	CHE127	Chemical Process Industries Lab	0	3	1
VIII	CSC128	Computer Aided Engineering Drawing Lab	0	3	1
IX	GEC129	General Engineering Lab	0	3	1
		Total:	14	12	18

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

3rd Semester

Paper	Course Code	Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	CHE231	Chemical Engineering Principles-II	3	0	3
II	CHE232	Heat Transfer	3	0	3
III	CHE233	Fluid and Particle Mechanics-I	3	0	3
IV	HUM234	Pakistan Studies	2	0	2
V	MTH235	Engineering Mathematics-III	3	0	3
VI	CHE236	Heat Transfer Lab	0	3	1
VII	CHE237	Fluid and Particle Mechanics-I Lab	0	3	1
VIII	CSC238	Computing and Computer Programming Lab	0	3	1
IX	HUM300	Quranic Translation	1	0	0
		Total:	14	9	17

4th Semester

Paper	Course Code	Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	CHE241	Particulate Technology	3	0	3
II	CHE242	Chemical Engineering Thermodynamics-I	3	0	3
III	NEN243	Technical Writing and Communication Skills	3	0	3
IV	CHE244	Fluid and Particle Mechanics-II	3	0	3
V	CHE245	Particulate Technology Lab	0	3	1
VI	CHE246	Fluid and Particle Mechanics-II Lab	0	3	1
VII	CHE247	Computer Applications in Chemical Engineering Lab	0	3	1
		Total:	12	9	15

5th Semester

Paper	Course Code		Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	Elective –I	CHE351A	Environmental Engineering	2	0	2
		CHE351B	Natural Gas Engineering – I			
		CHE351C	Nuclear Engineering			
II	CHE352		Chemical Engineering Thermodynamics-II	2	0	2
III	CHE353		Mass Transfer	3	0	3
IV	CHE354		Separation Processes-I	3	0	3
V	GEC355		Engineering Materials	2	0	2
VI	CHE356		Chemical Reaction Engineering	3	0	3
VII	CHE357		Separation Processes-I Lab	0	3	1
VIII	CHE358		Chemical Engineering Thermodynamics Lab	0	3	1
IX	CHE359		Chemical Reaction Engineering Lab	0	3	1
X	HUM500		Quranic Translation	1	0	0
			Total:	15	9	18

6th Semester

Paper	Course Code		Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	MGT361		Entrepreneurship	2	0	2
II	CHE362		Separation Processes-II	3	0	3
III	CHE363		Fuels and Combustion	3	0	3
IV	CHE364		Unit Processes	2	0	2
V	Elective – II	CHE365A	Polymer Engineering	2	0	2
		CHE365B	Natural Gas Engineering – II			
		CHE365C	Renewable Energy Engineering			
VI	CHE366		Separation Processes-II Lab	0	3	1
VII	CHE367		Fuels and Combustion Lab	0	3	1
VIII	CHE368		Unit Processes Lab	0	3	1
			TOTAL:	12	9	15

CHE 400 INTERNSHIP		CREDIT HOURS : 0

7th Semester

Paper	Course Code		Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	MGT471		Production and Operations Management	3	0	3
II	CHE472		Chemical Plant Design	3	0	3
III	CHE473		Instrumentation and Process Control	3	0	3
IV	CHE474		Design Project Part I	0	3	3*
V	Elective-III	CHE475A	Petrochemical Engineering	2	0	2
		CHE475B	Petroleum Refinery Engineering –I			
		CHE475C	Industrial Energy Systems			
VI	HUM476		Industrial Psychology, Sociology and Tolerance	2	0	2
VII	CHE477		Instrumentation and Process Control Lab	0	3	1
VIII	CHE478		Process Design and Simulation Lab	0	3	1
IX	HUM700		Quranic Translation	1	0	0
			Total:	13	9	18

8th Semester

Paper	Course Code		Course Title	Lecture Hours	Lab. Hours	Credit Hours
I	MGT481		Industrial Management and Process Economics	3	0	3
II	CHE482		Process Analysis and Optimization	3	0	3
III	CHE483		Design Project Part II	0	3	3*
IV	Elective – IV	CHE484A	Biochemical Engineering	2	0	2
		CHE484B	Petroleum Refinery Engineering – II			
		CHE484C	Food Engineering			
V	CHE485		Transport Phenomena	3	0	3
VI	CHE486		Chemical Plant Safety and Maintenance	2	0	2
VII	CHE487		Transport Phenomena Lab	0	3	1
			Total:	13	6	17

GRAND TOTAL CREDIT HOURS = 136

*As per PEC/HEC Guidelines

Course Outlines separately for each course

1ST SEMESTER

I CHE111 Chemical Process Industries-I

Course Outline

- **Title:** Chemical Process Industries - I
- **Code Number**: CHE111
- **Semester:** 1st
- **Credit Hours:** 3
- **Pre-requisites course requirements/ skills**: Basic knowledge of chemistry
- **Learning Outcomes:**

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

  1. Identify the process equipment with their standards symbols
  2. Comprehend the process flow diagrams (PFDs) for various processes.
  3. Understand the requirements for raw materials required for manufacturing various products.
  4. Describe process conditions, reactions involved and interaction of chemical process industries.
- **Contents**

  Unit I: Introduction and Fundamentals

  1.1 Introduction to Chemical Engineering and Process Industry
  1.2 History and Development of Chemical Process Industry in Pakistan.
  1.3 Drawing Symbols of equipment used in a process industry.
  1.4 Types of process diagrams
  1.5 Drawing of process flow diagrams using computer software like MS Visio.

  Unit II: Chemical Processes and Impact of Chemical Process Industry on Environment

  2.1 Water Sources and Usage
  2.2 Water treatment and Purification
  2.3 Environmental Impact of Chemical Process Industries
  2.4 Application of Sustainable Green Technology

  Unit III: Inorganic chemicals manufacturing

  3.1 Glass and Ceramics
  3.2 Cement
  3.3 Sulfuric Acid

3.4 Nitric Acid
3.5 Sodium carbonate and Sodium Hydroxide

Unit IV: Organic Chemicals Manufacturing

4.1 Oil and Fats
4.2 Soaps and Detergents
4.3 Paints and Coatings
4.4 Sugar

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and Reference books**

1. Austin, G.T., Shreve, R.N., Austin, G.T. (1997), "Shreve's Chemical Process Industries" 6th Edition, McGraw Hill.
2. Shahidi, F. (2005) "Bailey's Industrial Oil and Fat Products" Vol-V, 6th Edition, Wiley.
3. Mindess, S., Young, F. (1981) "Concrete" Prentice Hall.
4. Bhatia, S.C. (2004) "Chemical Process Industries" Vol-I, 2nd Edition, CBS.
5. Moulijn, J.A., Makkee, M., Diepen, A.E.V. (2013) "Chemical Process Technology" 2nd Edition, Wiley.

6. Pandey, G.N. (2000) "Textbook of Chemical Technology" 2nd Edition, Sangram Books.
7. Kent, J.A. (2012) "Riegel's Handbook of Industrial Chemistry" 9th Edition, Van Nostrand Reinhold.
8. Othmer, K. (2007) "Kirk Othmer Encyclopedia of Chemical Technology" Vol 1-26, 5th Edition, Wiley.
9. Parrish, A.E.M., Abraham, M.A. (2013) "Green Chemistry and Engineering: A Pathway to Sustainability" Wiley.

II MTH112 Engineering Mathematics-I

Course Outlines:

- **Title:** Engineering Mathematics-I
- **Code Number:** MTH112
- **Semester:** 1st
- **Credit Hours:** 2
- **Pre-requisites:** Basic knowledge of mathematical calculations
- **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. Transform raw data into useful statistics to compute central tendencies and dispersions.
- **Contents**

  Unit I: Differential Calculus

  1.1 Introduction and motivations: A review of limits, continuity and differentiation.

  1.2 Higher Derivatives, Total differential, The Product and Quotient Rules, Composite functions and chain rule, Implicit differentiation, Partial derivatives

  1.3 Applications of Derivatives
  - 1.3.1 Tangent and Normal
  - 1.3.2 Curvature and Radius of Curvature using Derivative
  - 1.3.3 Increasing and decreasing functions, Maxima and minima of a function of one variable
  - 1.3.4 Asymptotes and Concavity
  - 1.3.5 Applied Optimization

  1.4 Applying optimization in chemical processes

Unit II: Integral Calculus

2.1 Different Techniques of Integration, Definite integral and its properties
2.2 Fundamental theorem of Integral Calculus
2.3 Applications of Integration
  2.3.1 Area of cross-section, Arc length
  2.3.2 Volume of a solid, Volume of a solid of revolution, Volumes by cylindrical shells, Area of surface of revolution
  2.3.3 Fluid Pressure and Force
2.4 Use of Integration techniques in chemical engineering

Unit III: Statistics

3.1 Representation of Data, Graph and it types
3.2 Measure of Central Tendency, e.g. Mean, Mode and Median
3.3 Measure of Dispersion, e.g. Mean Deviation, Standard Deviation and Moments
3.4 Basic Probability: Laws of Probability with application to engineering
3.5 Probability distributions, Binomial distribution, Normal and Uniform distribution
3.6 Methods of Least squares and curve fitting
3.7 Regression analysis and sampling distribution

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

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

- **Textbooks and reference readings**

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

III NEN113 Functional English

Course Outlines

- **Title:** Functional English
- **Code Number:** NEN113
- **Semester:** 1st
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** Basic knowledge of english language
- **Learning Outcomes:**

  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 messages.
  3. Comprehend instructions effectively.

- **Contents**

  Unit I: Basics of Grammar

  1.1 Parts of speech and use of articles

1.2 Sentence structure, active and passive voice
1.3 Analysis of phrase, clause and sentence structure
1.4 Transitive and intransitive verbs
1.5 Punctuation and spelling

Unit II: Comprehension

2.1 Discussion on General topics and every-day conversation Translation skills: Urdu to English
2.2 Paragraph writing

Unit III: Presentation skills

3.1 Vocabulary building exercises
  3.1.1 Synonyms, antonyms and homonyms
  3.1.2 One-word substitution
  3.1.3 Idiomatic sentences
  3.1.4 Correction of errors

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

    1. Thomas, A.J., Martinet, A.V. (1993) "A Practical English Grammar" 4th Edition, Oxford University.
    2. Wren, P.C., Martin, H., Rao, N.D.V.P. (2016) "High School English Grammar and Composition" S. Chand Company.
    3. Boutin, M.C., Maley, Brinand, S., Grellet, F. (1993), "Writing: Intermediate" 4th Edition, Oxford University.
    4. Tomlinson, B., Ellis, R. (1987) "Reading: Upper-intermediate" 4th Edition, Oxford University.

IV HUM114 Islamic Studies

Course Outlines

- **Title:** Islamic Studies
- **Code Number:** HUM114
- **Semester:** 1st
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** Intermediate level
- **Learning Outcomes:**

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

    1. Describe living with peace, respect and free of 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.

- **Contents, textbooks and reference readings**

    Unit I: Translation of Holy Quran

Unit II:

اسلامیات لازمی

پرچہ میں نمبروں کی تقسیم درج ذیل ہوگی۔

قرآن حکیم موضوعاتی مطالعہ	30 نمبر
اسوہ حسنہ	15 نمبر
اسلامی تہذیب	15 نمبر
میزان:	60 نمبر

(1) قرآن حکیم (موضوعاتی مطالعہ)

اسلامیات لازمی کے پرچہ میں طالب علموں کے لئے لازمی ہوگا کہ کم از کم چار آیات اور دو احادیث کا ترجمہ اور تشریح کرے۔

قرآن حکیم (موضوعاتی مطالعہ) میں 30 نمبروں کی تقسیم درج ذیل ہوگی

آیات کا ترجمہ	8 = 4x2 نمبر
آیات کی تشریح	12= 4x3 نمبر
احادیث کا ترجمہ	4= 2x2 نمبر
احادیث کی تشریح	6 = 3x2 نمبر
میزان:	30 نمبر

(نوٹ) موجودہ سکیم کے تحت بی اے، بی ایس سی اور پروفیشنل ڈگری پروگرامز میں داخل ہونے والے طلباء طالبات قرآن حکیم ناظرہ مکمل کر چکے اور قرآن کے بیشتر حصے کا ترجمہ بھی پڑھ چکے ہوں گے۔ اس لئے اس مرحلے میں قرآن حکیم کا

موضوعات

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احادیث

1- عن عمر بن الخطاب قال قال رسول الله حين سئل عن الايمان ان تومن بالله و ملائكته و كتبه ورسله واليوم و تومن بالقدر خيره وشره (متفق عليه)

2- عن العباس بن عبدالمطلب قال قال رسول ذاق طعم الايمان من رضى بالله ربا وبالاسلام دينا وبحمد رسولا (مسلم)

2- عن عبدالله بن عمر قال قال رسول الله الا كلكم راع و كلكم مسئول عن رعيته فالا مام الذى على الناس راع وهو مسئول عن رعيته والرجل راع على اهل بيته وهو مسئول عن رعيته والمر آة راعية على بيت زوجها وولده وهى مسئولة عنهم و عبدالرجل راع على مال سيده و هو مسئول عنه الافكلكم راع و كلكلم مسئول عن رعيته (متفق عليه)

(IV) اتحادامت

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احادیث

1- عن انس قال قال رسول الله والذى نفسى بيده لا يو عبدحتى يحب لا خيه ما يحب لنفسة (متفق عليه)

2- عن النعمان بن بشير قال قال رسول الله ترى الومنين فى تراحهم و توادهم و تعاطفهم كمثل الجسد اذا اشتكى عضو تداعى له سائر الجسدبالشهر والحمى(متفق عليه)

(V) کسب حلال

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احادیث

1- عن ابن عمر رضی اللہ عنھما قال قال رسول اللہ بنی الاسلام علی خمس شھادۃ ان لا الہ اللہ وان محمد اعبدہ ورسولہ واقام الصلوۃ وایتاء الزکاۃ والحج وصوم رمضان - (متفق علیہ)

2- وفی حدیث جبریل قال رسول اللہ : الاسلام ان تشھد ان لا الہ اللہ و ان محمد ارسول اللہ وتقیم الصلاۃ وتوتی الزکاۃ وتصوم رمضان وتحج البیت ان استطاعت الیہ سبیلا (متفق علیہ)

(III) امر بالمعروف ونہی عن المنکر

(الف) دعوت دین کی ضرورت واہمیت

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1- عن النعمان بن بشير قال قال رسول الله الاحلال بين والحرام بين و بينهما متشبهات لا يعلمهن كثير من الناس فمن اتقى الشبهات استبرا لدنيه و عرضه ومن وقع فى الشبها وقع فى الحرام كالراعى يرعى حول الحمى يوشك ان يرتع فيه الا وان لكل ملك حمى الاوان حمى الله محارمه الا وان فى الحسد مضفضة اذا صلحت صلح الحسد كله واذا فسدت فسد الحسد كله الاوهى القلب (متفق عليه)

2- عن ابى هريره قال قال رسول الله ان الله طيب لا يقبل طيبا وان الله امر المومنين بماامر به المرسلين فقال يايها الرسل كلوا من الطيبت واعلموا صالحا وقال تعالى يايها الذين امنوا كلوا طيبت مارزقنا كم ثم ذكر الرجل يطيل السفراشعث اغبر يمديديه الى السماء يا رب يا رب و مطعمه حرام ومشربه حرام وملبسه حرام وغذى بالحرام فاتى يستحاب لذلك(رواه مسلم)

(VI) حقوق العباد

(الف بنیادی انسانی حقوق

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(ح) حق مساوات

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(خ) معاشی تحفظ

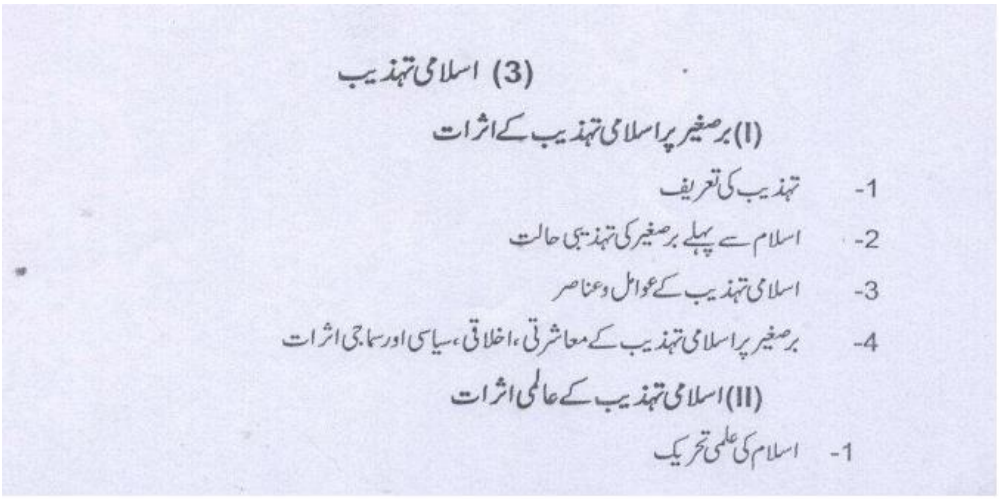
ترجمہ اور اہم نکات

مذکورہ بالا تمام عنوانات کی قرآنی آیات کی تفسیر میں عنوان کے تحت احادیث دے دی گئی ہیں۔

(2)اسوہ حسنہ(سیرت طیبہ)

سیرت طیبہ کے موجودہ ترتیب کو جوں کا توں برقرار رکھنا چاہیے

1- ولادت باسعادت
2- قبل از نبوت کی زندگی
3- بعثت نبوی
4- دعوت وتبلیغ اور اس کی مشکلات
5- ہجرت مدینہ
6- مواخات اور میثاق مدینہ
7- غزوات نبوی
8- حجتہ الوداع
9- وصال



(3) اسلامی تہذیب

(I) برصغیر پر اسلامی تہذیب کے اثرات

1- تہذیب کی تعریف

2- اسلام سے پہلے برصغیر کی تہذیبی حالت

3- اسلامی تہذیب کے عوامل وعناصر

4- برصغیر پر اسلامی تہذیب کے معاشرتی، اخلاقی، سیاسی اور سماجی اثرات

(II) اسلامی تہذیب کے عالمی اثرات

1- اسلام کی علمی تحریک

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

IV HUM114 Ethics

Course Outlines

- **Title:** Ethics
- **Code Number:** HUM114
- **Semester:** 1st
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** Basic knowledge of social norms
- **Learning Outcomes:**

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

  1. Describe and appreciate the common ground of all religions.
  2. Develop graduates with moral and ethical behaviour.
  3. Respect the cultures of other religions.

- **Contents**

  Unit I: Scope of Ethics

  1.1 Definition and scope of ethics
  1.2 Relation of ethics to psychology, metaphysics and religion

  Unit II: Major theories and moral standards

  2.1 A brief review of major theories and moral standards
  - 2.1.1 The standard as Law
  - 2.1.2 The standard as happiness
  - 2.1.3 The standard as Perfection

  Unit III: Moral Values

  3.1 Promotion of moral values in society through family and various educational and cultural institutions
  3.2 Concept of
  - 3.2.1 good and evil
  - 3.2.2 Freedom and responsibilities

  3.3 Various theories of punishment

  Unit IV: Ethical teachings of world religions

  4.1 Ethical teachings of world religions with special references to Hinduism, Christianity, Buddhism, Judaism, and Islam

Unit V: Ethical percepts of Islam

5.1 100 ethical percepts of Islam and the sayings of the Holy Prophet (PBUH)

5.2 Islam attitude towards minorities

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

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

- **Textbooks and reference readings**

1. J.S. Mackenzie: A Manual of Ethics.
2. Harol H. Titus: Ethics for To-day.
3. B.A. Dar: Quranic Ethics.
4. Proceedings of to Islamic Colloquium, Lahore 1957.
5. اسلامی ریاست: سید ابوالاعلی مودودی (مطبوعہ اسلامک پبلیکیشنز لاہور)

V PHY115 Applied Physics

Course Outlines

- **Title:** Applied Physics
- **Code Number:** PHY115
- **Semester:** 1st
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** Basic knowledge of applied sciences.
- **Learning Outcomes:**

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

  1. Understand basic principles and problems of physics.
  2. Acquire knowledge of materials characterization techniques.
  3. Understanding of nano physics applications in the chemical engineering.
  4. Solve engineering problems related to modern electronics.

- **Contents:**

Unit I: Introduction to engineering mechanics

1.1 Physical significance of engineering Mechanics
1.2 Mechanics of Coplanar and Non-Coplanar forces
1.3 Equilibrium of Rigid Bodies in 2 and 3-dimensions

Unit II: Introduction to electromagnetic theory

2.1 Electrostatics, Magnetostatics
2.2 Electromagnetic Theory
2.3 Maxwell Equations
  2.3.1 Gauss' Law for electricity
  2.3.2 Gauss' Law for Magnetism
  2.3.3 Faraday's Law
  2.3.4 Ampere-Maxwell Law

Unit III: Modern, quantum and nuclear physics

3.1 Einstein's Photoelectric Effect Law
3.2 Planck's Black-body Radiation Law

3.3 Quantum Theory of matter
3.4 Quantum Theory of Radiation
3.5 Physical significance of Quantum Mechanics
3.6 Modern Nuclear Physics in Engineering Domain

Unit VI: Engineering electronics & Industrial Revolution IV

4.1 Introduction to microelectronics: Active & Passive Components
    4.1.1 Integrated Circuits (IC): Classification & Fabrication of ICS
    4.1.2 Advantages of ICS
4.2 Introduction to Digital Electronics: Number Systems & Logic Gates
    4.2.1 Truth Table & K-Map
    4.2.2 Designing of 3-bit adder, 2-bit adder
    4.2.3 Digital Circuits & Electronic Suitcase
4.3 Introduction to Industrial Revolution 4: Challenges and Expectations
    4.3.1 3-D Printing
    4.3.2 IOT
    4.3.3 Fusion of Technologies
4.4 IOT: Challenges of digital process control systems.
    4.4.1 Internet of Things: Tools and Solutions
    4.4.2 Digital networking in Process control
    4.4.3 Horizontal and Vertical Integration in Digital Process control
4.5 Introduction to Digital communications
    4.5.1 Process Control Parameters & Advanced Digital communications
    4.5.2 IPCs and Digital Controller
    4.5.3 Digital Designing: Process Parameters Flow sheet
    4.5.4 Digital Logic Controller & Distributed Control Systems
4.6 Case Studies: Industrial Revolution 4 in Chemical Engineering

Unit V: Nano science and nanotechnology in chemical engineering

5.1 Why does size Matter? nanotechnology is future
5.2 Nanotechnology in nature
5.3 Nano materials and physical properties
5.4 Various synthesis techniques of nanomaterials
5.5 Top down approach, bottom up approach
5.6 Chemical and physical synthesis approaches
5.7 Applications of nanotechnology in chemical engineering

Unit VI: Applied physics techniques in engineering

6.1 Significance of applied techniques in engineering
6.2 X-ray Diffraction Technique (XRD)
6.3 Scanning Electron Microscope/Tunnelling Electron Microscope
6.4 Fourier Transfer Infrared Spectroscopy (FTIR)
6.5 Raman Spectroscopy

Unit VII: Applied physics applications in chemical engineering

7.1 Superior Energy Storage in Lithium Ion Batteries
7.2 Energy capacity in super capacitors
7.3 Water purification using nanoscience
7.4 Analysis of chemical compounds by characterization techniques
7.5 Bio chemical drug delivery
7.6 Porous Membranes
7.7 Microelectronics and nanoelectronics in chemical engineering
7.8 Novel chemical materials using nanotechnology
7.9 Chemical sensors

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

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

- **Textbooks and reference readings**

1. Mansfield, M., Osullivan, C. (2010), "Understanding Physics", 2nd Edition, Wiley.
2. Cutnell J.D., (2009), "Introduction to Physics", 8th Edition, Wiley.
3. Dale Ewin, (2009), "Applied Physics", Prentice Hall.
4. Albert T., Fromhold Jr., (2011), "Quantum Mechanics for applied physics and engineering", Dover.
5. Dale Ewin, Neil Schurter, Erik Gundersen (2016), "Applied Physics", 11th Edition, Pearson.
6. Said, S Elnashaie, Firoozeh Danafar, Hassan Hashemipour Rafsanjani, (2015), "Nanotechnology for chemical Engineers", Springer.
7. N. Gupta, (2012), "Nanophysics", SBS.

VI CHEM116 Applied Chemistry

Course Outline

- **Title:** Applied Chemistry
- **Code Number:** CHEM116
- **Semester:** 1st
- **Credit Hours:** 3
- **Pre-requisites course requirements/ skills:** Basic knowledge of applied sciences.
- **Learning Outcomes:**

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

  1. Comprehend chemistry involved in manufacturing of organic and inorganic products.

2. Describe the mechanism of reaction of raw materials for synthesis of various products.
3. Devise reaction scheme for synthesis of industrially important chemicals.

- **Contents**

Unit I: Introduction

1.1 Basic chemistry of various ores found in Pakistan
1.2 Coordination compounds and ligands
1.3 Complexes of different coordination numbers
1.4 Water: Chemistry, Reactivity, Hydrates
1.5 Chemistry of industrial aqueous and non-aqueous solvents
1.6 Industrial inorganic chemistry
1.7 Introduction to nuclear chemistry

Unit II: Petrochemical Chemistry

2.1 Alkanes, Cycloalkanes, alkenes, alkynes, aromatic compounds
2.2 Heterocyclic organic compounds of sulphur, oxygen and nitrogen, generally present in crude petroleum.
2.3 Chemistry of Organometallic compounds related to chemical process and petroleum industries
2.4 Chemistry of Carbohydrates, lipids and proteins
2.5 Dyestuff chemistry
2.6 Brief treatise on stereo chemistry

Unit III: Thermoplastics and Viology

3.1 Production of Industrially Important Thermoplastics
3.2 Links between chemical structure and properties of various industrially important Thermoplastics
3.3 Innovation in Polymerization
3.4 Co-Polymerization, Blending and Modification

Unit IV: Oils and Fats

4.1 Natural Fats and their classification
4.2 Iodine Value and Saponification Values
4.3 Chemistry of Soap and Detergents

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

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

- **Textbooks and reference readings**

1. Goel N. (2004), "Concise Engineering Chemistry", AITBS.
2. Girard, J. (2013), "Principles of Environmental Chemistry", Jones and Barlett Learning.
3. Budinski, K.G., Budinski, M.K. (2010), "Engineering Materials: Properties and Selection", 9th Edition, Prentice Hall.
4. Ghosh, P. (2001), "Polymer Science and Technology: Plastics, Rubbers, Blends and Composites", 2nd Edition, Tata McGraw Hill.
5. Bahl, A. (2010), "Advanced Organic Chemistry", S. Chand Company.

VII GEC117 Engineering Drawing Lab

Course Outlines

- **Title:** Engineering Drawing Lab
- **Code Number:** GEC117
- **Semester:** 1st

- **Credit hours**: 1
- **Pre-requisites course requirements/ skills:** Basic knowledge of drawings
- **Learning Outcomes:**

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

  1. Describe projection theory, role of engineering drawing, and interpret engineering drawings
  2. Construct orthographic projections of given isometric views on drawing sheets
  3. Draw piping drawings

- **Contents**

  Unit I: Introduction

  1.1 Engineering design cycle and graphics design
  1.2 Elements of engineering drawing
  1.3 Drawing standards
  1.4 Drawing sheet, basic line types , meaning of lines, drawing tools and sketching techniques

  Unit II: Projection theory

  2.1 Projection methods, orthographic projection, six principal view
  2.2 Projection systems and isometric drawing
  2.3 Projection of points and lines: Quadrants and plane of projection and projection of lines

  Purpose **Unit III: Dimensioning**

  3.1 Dimensioning components, angle, fillets, rounds, cylinders, holes, chamfer and rounded end shape

  Unit IV: Sectioning

  4.1 Section views
  4.2 Cutting plane, cutting plane line, cutting plane line styles
  4.3 Treatment of hidden lines and types of sections

  Unit V: Engineering geometry

  5.1 Shape description and geometric elements classification
  5.2 Orthographic writing and reading
  5.3 Tangency and intersection: One-view drawing and two-view drawing

  Unit VI: Joining of materials

6.1 Assemblies, types of assemblies
6.2 Types of joints, welding, the weld joint, types of joints and types of weld

Unit VII: Geometric tolerances

7.1 Types of fits
7.2 Pipes and pipe joints
7.3 Valves

- **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.

  Lab Lectures: 3 contact hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written/Practical examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: lab participation, attendance and assignments.
3.	Final Assessment	40%	Written/Practical examination at the end of semester.

- **Textbooks and reference readings**

1. Parkinson, A.C. (1940) "A First Year Engineering Drawing" 2nd Edition, Piman.
2. Bertoline, G.R., Wiebe, E.N. (2003) "Technical Graphics Communication" McGraw Hill.
3. French, T.E., Vierck, C.J., Foster, R.J. (1993) "Engineering Drawing and Graphic Technology" 14th Edition, McGraw Hill.
4. Wallach, P.R. (1979) "Metric Drafting" Glencoe.

VIII PHY118 Applied Physics Lab

Practicals pertaining to the course outlined in PHY115

IX CHEM119 Applied Chemistry Lab

Practicals pertaining to the course outlined in CHEM116

X HUM100 Quranic Translation

The students will learn Holy Quran with translation in this module. The module is added as per decision of Academic Council.

2ND SEMESTER

I CHE 121 Chemical Process Industries- II

Course Outline

- **Title:** Chemical Process Industries - II
- **Code Number:** CHE121
- **Semester:** 2nd
- **Credit Hours:** 3
- **Pre-requisites course requirements/ skills:** Basic knowledge of chemistry
- **Learning Outcomes:**

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

  1. Understand process, conditions and sequence of equipment using process flow diagrams.
  2. Develop a diagram using process description.
  3. Describe process variables, raw material characteristics and process equipment.

- **Contents**

Unit I: Chemical Industry

1.1 The Age of Sustainability and Global Trends in the Chemical Industry
1.2 Fossil Fuel Consumption and Reserves
1.3 Biomass as an Alternative for Fossil Fuels
1.4 Energy and the Chemical Industry
1.5 Composition of Fossil Fuels and Biomass

Unit II: Processes in Oil Refinery

2.1 The Oil Refinery Overview
2.2 Physical Processes
2.3 Thermal Processes
2.4 Catalytic Processes
2.5 Current and Future Trends in Oil Refining

Unit III: Processes for the Conversion of Biomass

3.1 Production of Biofuels
3.2 Production of Bio-based Chemicals

3.3 The Bio refinery

Unit IV: Production of Polymers

4.1 Polymerization Reactions
4.2 Polyethenes – Background Information
4.3 Processes for the Production of Polyethenes
4.4 Plastic Industries, Types of plastic resins and their manufacture, Synthetic fiber manufacture.

Unit V: Fertilizer Industries

5.1 Urea manufacture
5.2 Ammonium Nitrate manufacture
5.3 Di-ammonium phosphate manufacture
5.4 Super phosphate manufacture.

Unit VI: Pulp and Paper Industries

6.1 Chemical pulping methods
6.2 Paper making machine
6.3 Environmental concerns of pulp and paper industries.

Unit VII: Process Development

7.1 Dependence of Strategy on Product Type and Raw Materials
7.2 The Course of Process Development
7.3 Development of Individual Steps
7.4 Scale-up
7.5 Safety and Loss Prevention
7.6 Process Evaluation

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

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

- **Textbooks and Reference books**

1. Austin, G.T., Shreve, R.N., Austin, G.T. (1997), "Shreve's Chemical Process Industries" 6th Edition, McGraw Hill.
2. Heaton, C.A. (1996), "An introduction to Industrial Chemistry" 3rd Edition, Springer.
3. Mindess, S., Young, F. (1981) "Concrete" Prentice Hall.
4. Bhatia, S.C. (2004) "Chemical Process Industries" Vol-I, 2nd Edition, CBS.
5. Moulijn, J.A., Makkee, M., Diepen, A.E.V. (2013) "Chemical Process Technology" 2nd Edition, Wiley.
6. Pandey, G.N. (2000) "Textbook of Chemical Technology" 2nd Edition, Sangram Books.
7. Kent, J.A. (2012) "Riegel's Handbook of Industrial Chemistry" 9th Edition, Van Nostrand Reinhold.
8. Othmer, K. (2007) "Kirk Othmer Encyclopedia of Chemical Technology" Vol 1-26, 5th Edition, Wiley.
9. Parrish, A.E.M., Abraham, M.A. (2013) "Green Chemistry and Engineering: A Pathway to Sustainability" Wiley.
10. Shahidi, F. (2005) "Bailey's Industrial Oil and Fat Products" Vol- V, 6th Edition, Wiley.

II CHE122 Chemical Engineering Principles-I

Course Outlines

- **Title:** Chemical Engineering Principles-I
- **Code Number:** CHE122
- **Semester:** 2nd
- **Credit hours:** 3

- **Pre-requisites course requirements/ skills:** Basic knowledge and understanding of engineering science principles, physical laws, and mathematical tools and solution of linear algebraic equations.
- **Learning Outcomes:**

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

  1. Familiarize with role and responsibilities of a Chemical Engineer in professional life
  2. Acquire the basic knowledge of Chemical Engineering principles.
  3. Solve the problems related to dimensional analysis and process variables
  4. Stoichiometry and material balances for process units

- **Contents**

  Unit I: Chemical Engineering Professional life

  1.1 Introduction and background of Chemical Engineering profession
  1.2 Chemical Process Industries
  1.3 Role and Responsibilities of Chemical Engineer
  1.4 Chemical Engineer Professional Ethics
  1.5 Current and future contributions of chemical Engineering

  Unit II: Chemical Engineering Calculations

  2.1 Basic concepts of Chemical Engineering
  2.2 Units and Dimensions
  2.2.1 System of Units
  2.2.2 Conversion of Units
  2.3 Dimensional Analysis
  2.4 Numerical Calculation and Estimation

  Unit III: Processes and Process Variables

  3.1 Mass and Volume
  3.2 Density and Specific gravity
  3.3 Chemical Composition
  3.4 Flowrate
  3.5 Choosing a Basis
  3.6 Pressure
  3.7 Temperature

  Unit IV: Material Balance

  4.1 Processes Classification

4.2 Fundamentals of material balances
4.3 Material Balance Calculations
4.3.1 Single process unit
4.3.2 Multiple Process units
4.4 Balances on non-reactive systems
4.5 Case studies on balances for important industrial processes

- **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.

Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

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

- **Textbooks and reference readings**

1. Himmelblau, D.M., Riggs, J.B. (2012) "Basic Principles and Calculations in Chemical Engineering" 8th Edition, Prentice Hall.
2. Felder, R.M., Rousseau, R.W., Bullard, L.G., Newell, J.A. (2016) "Felder's Elementary Principles of Chemical Processes" 4th Edition, Wiley.
3. Reklaitis, G.V., Schneider, D.R. (1983) "Introduction to Material and Energy Balances" Wiley.
4. Hicks, T., Chopey, N. (2012) "Handbook of Chemical Engineering Calculations" 4th Edition, McGraw Hill.

III MTH123 Engineering Mathematics-II

Course Outlines:

- **Title:** Engineering Mathematics-II
- **Code Number:** MTH123
- **Semester:** 2nd
- **Credit Hours:** 3
- **Pre-requisites course requirements/ skills:** MTH112
- **Learning Outcomes:**

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

  1. Recognize and solve linear, nonlinear and higher order ODEs with their applications.
  2. Illustrate power series solutions of ODEs with variable coefficients.
  3. Apply various numerical techniques to solve system of linear, non-linear algebraic and ordinary differential equations.
  4. Develop an intuitive understanding to solve basic physical and engineering problems using numerical methods.
- **Contents**

Unit I: Ordinary Differential Equations

1.1 Classification of Differential Equations, basic definitions and terminologies, Implicit and Explicit solutions, First order differential equations

1.2 First order linear equations

1.2.1 Method of Integrating Factor, Separable variables

1.2.2 Exact equations, Homogeneous equations, Initial value problems

1.2.3 Orthogonal Trajectories

1.3 Non-linear equations, Bernoulli's equation, Riccati equation

1.4 Modeling, Systems of ODEs as Models in Engineering Applications

Unit II: Higher Order Ordinary Differential Equations

2.1 Homogeneous Linear ODEs with Constant Coefficients

2.2 Nonhomogeneous Linear ODEs

2.3 Complimentary and Particular solutions

2.4 Undetermined coefficient approach, Variation of parameter

2.5 Case studies in chemical engineering

Unit III: Power Series

3.1 Ordinary differential equations with variable coefficients

3.2 Series solution of ODEs around Ordinary Points
3.3 Singular points, Legendre and Bessel Equations
3.4 Regular singular points and Method of Frobineous

Unit IV: Numerical Analysis

4.1 Basic Definitions of Numerical Analysis
4.2 Numerical approximations over analytic techniques
4.3 Numerical Solutions of linear and nonlinear algebraic and Transcendental equations
4.4 Numerical Differentiation and Integration
4.5 Interpolation schemes
4.6 Numerical solution of ordinary differential equations.

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and Suggested Readings**

1. Boyce, W.E., Diprima, R.C., Meade, D.B. (2017) "Elementary Differential Equations and Boundary Value Problems" 11th Edition, Wiley.

2. Kreyszig, E., Kreyszig, H., Norminton, E.J. (2011) "Advanced Engineering Mathematics" 10th Edition, Wiley.
3. Zill, D.G., Wright, W.S., Cullen, M. R. (2013) "Differential Equations with Boundary Value Problems" 8th Edition, McMillan.

IV GEC124 General Engineering

Course Outlines

- **Title:** General Engineering
- **Code Number:** GEC124
- **Semester:** 2nd
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** Basic knowledge of engineering sciences, physical laws, and mathematical tools.
- **Learning Outcomes:**

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

  1. Understand the concepts related to the mechanical equipment.
  2. Apply knowledge to solve mechanical problems.

- **Contents**

  Unit I: Theory of Machines

  1.1 Power transmission introduction
  - 1.1.1 belts ropes
  - 1.1.2 chains, governors
  - 1.1.3 flywheels, gears

  1.2 Efficiency of machines.

  Unit II: Prime Movers

  2.1 Introduction
  2.2 Boilers: elementary theory and operation
  2.3 Steam engines
  2.4 Power and efficiency of steam engines
  - 2.4.1 Internal combustion engines
  - 2.4.2 Jet propelled engines

  Unit III: Electrical

  3.1 Introduction

3.1.1 A.C. Motors
3.1.2 Construction
3.1.3 Types
3.1.4 Working Principle
3.1.5 Applications
3.2 Capacitance Calculations
3.3 Singles and Three phase system

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final Term

- **Assessment and Examinations:**

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

- **Textbooks and reference readings**

1. Meriam, J.L., Kraige, L.G. (2012) "Engineering Mechanics Dynamics" Vol II, 7th Edition, Wiley.
2. Weedy, B.M., Cory, B.J., Jenkins, N., Ekanayake, J.B., Strbac, G. (2012) "Electric Power Systems" 5th Edition, Wiley.
3. Horowitz, P., Hill, W. (2015) "The Art of Electronics" Cambridge University.
4. Kasap, S.O. (2005) "Principles of Electronic Materials and Devices" 3rd Edition, McGraw Hill.
5. Bolton, W.C. (2013) "Mechanical Science" 3rd Edition, Wiley.

V CHEM125 Physical Chemistry

Course Outlines

- **Title:** Physical Chemistry
- **Code Number:** CHEM125
- **Semester:** 2nd
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** Basic knowledge of applied sciences.
- **Learning Outcomes:**

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

  1. Describe surface tension, capillarity, adsorption and its applications, catalysis, electrical double layers.
  2. Comprehend the experimental kinetics, reaction rates and photo chemistry.
  3. Grasp the concepts of Electrochemistry, Electrolysis and electrical conductance, industrial electrochemical processes and electrochemical cells.
  4. Understand the application of Colloids and Colloidal solution, osmosis reverse osmosis, and membranes.

- **Contents**

  Unit I: Surface Phenomena

  1.1 Surface tension

  1.2 Capillarity

  1.3 Adsorption and application of adsorption

  1.4 Catalysis

  1.5 Enzyme catalysis

  1.6 Electrical double layers

  1.7 Colloids

  Unit II: Chemical Kinetics

  2.1 Kinetic theory of gases

  2.2 Experimental Kinetics and Gas Reactions Rate Laws

  2.3 Reaction rates

  2.4 Photo chemistry

  Unit III: Electrochemistry

3.1 Electrolysis and electrical conductance

3.2 Theory of electrolytic dissociation

3.3 Ionic equilibria

3.4 Electrochemical cell

3.5 Industrial electrochemical process

Unit IV: Membranes

4.1 Osmosis

4.2 Reverse Osmosis

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Maron, S.H., Lando, J.B. (1974) “Fundamentals of Physical Chemistry” MacMillan.
2. Kapoor, K.L. (2019) “A Textbook of Physical Chemistry: Computational Aspects in Physical Chemistry” McGraw Hill.
3. Metiu, H. (2019) “Physical Chemistry” Taylor & Francis.
4. Pashley, R.M., Karaman, M.E. (2004) “Applied Colloid and Surface Chemistry” Wiley.

5. Bahl, B.S., Bahl, A., Tuli, G.D. (2000) "Essentials of Physical Chemistry" S. Chand Company
6. Somorjai, G.A., Li, Y. (2010) "Introduction to Surface Chemistry and Catalysis" 2nd Edition, Wiley.
7. Hofmann, A. (2018) "Physical Chemistry Essentials" Springer.
8. Silbey, R.J., Alberty, R.A., Bawendi, M.G. (2004) "Physical Chemistry" Wiley.

VI CHEM126 Physical Chemistry Lab

Practicals pertaining to the course outlined in CHEM125

VII CHE127 Chemical Process Industries Lab

Practicals pertaining to the course outlined in CHE111, CHE 121

VIII CSC128 Computer Aided Engineering Drawing Lab

Course Outlines

- **Title:** Computer Aided Engineering Drawing Lab
- **Code Number:** CSC128
- **Semester:** 2nd
- **Credit hours**: 1
- **Pre-requisites course requirements/ skills:** Basic knowledge of drawings
- **Learning Outcomes:**

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

  1. Illustrate the use of computer software for various applications engineering drawings and generate projection (mainly orthographic projection).
  2. Apply basic feature of MS Visio and CAD tools for 2D drawings and 3D Models
  3. Prepare the formal lab report
- **Contents**

  Unit I: Introduction to MS Visio

  1.1 User Interface introduction
  1.2 Elements of MS Visio
  1.3 Drawing tools and sketching techniques

  Unit II: Projection theory

  2.1 Projection methods, orthographic projection, six principal view
  2.2 Projection systems and isometric drawing
  2.3 Projection of points and lines: Quadrants and plane of projection and projection of lines

Unit III: Dimensioning

3.1 Dimensioning components, angle, fillets, rounds, cylinders, holes, chamfer and rounded end shape

Unit IV: AutoCAD Introduction

4.1 Introduction to AutoCAD: User interface
4.2 Entity selection
4.3 Setting drawing limits
4.4 Using the grid and snap
4.5 Creating drawing geometry
4.6 Modifying drawing geometry
4.7 Using Ortho, polar and object tracking
4.8 Object snapping
4.9 Screen manipulation
4.10 Text creation and editing
4.11 Dimension creation and editing
4.12 Layouts, paper space, plotting
4.13 Introduction to 3D drawing

- **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.

  Lab Lectures: 3 contact hours per week , Required software: MS Visio, AutoCAD

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written/Practical examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: lab participation, attendance, assignments and performance on computer.
3.	Final Assessment	40%	Written/Practical examination at the end of semester.

- **Textbooks and reference readings**

1. Parkinson, A.C. (1940) “A First Year Engineering Drawing” 2nd Edition, Piman.
2. Vierk, C.J., Foster, R. J. (2007) “Engineering Drawing and Graphic Technology” 14th Edition T.E. French
3. Bhatt, N.D. (1998) “Elementary Engineering Drawing” The English Book Society and Pergamon.
4. Parkinson A.C. (1995) “First year to Engineering Drawing” The English Book Society and Pergamon.
5. Ching, Francis, D.K., (1997), “Design Drawing”, Wiley & Sons.

IX GEC129 General Engineering Lab

Practicals pertaining to the course outlined in GEC124.

3RD SEMESTER

I CHE231 Chemical Engineering Principles-II

Course Outlines

- **Title:** Chemical Engineering Principles-II
- **Code Number:** CHE231
- **Semester:** 3rd
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** Basic knowledge and understanding of engineering science principles, physical laws, and mathematical tools and solution of linear algebraic equations.

- **Learning Outcomes:**

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

  1. Describe the role of physical laws governing mass and energy balance calculations
  2. Acquire skills through SOPs for mass and energy balance calculations
  3. Solve technical problems associated with mass and energy balance calculations.

- **Contents**

  Unit I: Material Balance with Chemical Reactions

  1.1 Steps required for analysis of case study
  1.2 Degree of freedom analysis
  1.3 Decision making for elemental or component balance
  1.4 Mathematical tools for the solution of set of equations

  Unit II: Material Balance Involving Multiple Subsystems

  2.1 Concepts of subsystems
  2.2 Solution strategy for multiple subsystems

  Unit III: Recycle, Bypass and Purge Calculations

  3.1 Definition and concept of recycle stream in process industries
  3.2 Definition and concept of bypass stream in process industries
  3.3 Definition and concept of purge stream in process industries
  3.4 Industrial applications of recycle, bypass and purge streams

3.5 Recycle and bypass with and without chemical reactions
3.6 Computer aided tools for complex numerical calculations such as Mat-lab or maple software for problem solving

Unit IV: Gases, Vapours, Liquids and Solids

4.1 Material handling in process industries
4.2 Handling of gases or gaseous mixtures
4.3 Gas laws and their calculations
4.4 Real gas relationships
4.5 Distinction between vapour and gas
4.6 Vapour pressure and liquids
4.7 Methods for determining vapour pressure
4.8 Conditions of saturation and partial saturation
4.9 State of equilibria
4.10 Humidity and molal saturation
4.11 Material balance involving condensation and vaporization

Unit V: Concept of Energy Balance

5.1 Role of energy balance in Chemical Engineering and its applications
5.2 Law of conservation of energy
5.3 First law of thermodynamics
5.4 Reversible processes and mechanical energy balance
5.5 Enthalpy calculations
5.6 Derivation of energy balance equation for both batch and continuous process
5.7 Derivation of energy balance equation for both reactive and non-reactive systems

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Himmelblau, D.M., Riggs, J.B. (2012) "Basic Principles and Calculations in Chemical Engineering" 8th Edition, Prentice Hall.
2. Felder R. M., Rousseau R. W., Bullard L. G., Newel J. A. (2016) "Elementary Principles of Chemical Processes" 4th Edition, Wiley.
3. Reklaitis, G.V., Schneider, D.R. (1983) "Introduction to Material and Energy Balances" Wiley.
4. Hicks, T., Chopey, N. (2012) "Handbook of Chemical Engineering Calculations" 4th Edition, McGraw Hill.

II CHE 232 Heat Transfer

Course Outlines

- **Title:** Heat Transfer
- **Code Number:** CHE232
- **Semester:** 3rd
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** Basic knowhow of modes of heat transfer
- **Learning Outcomes:**

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

  1. Understand heat transfer modes in engineering systems.
  2. Compare the rates of heat transfer in solids and fluid flow systems by various modes of heat transfer.
  3. Solve problems related to heat transfer in engineering applications.

- **Contents**

Unit I: Basics of Heat Transfer

Unit II: Heat Conduction Equation

Unit III: Transient Heat Conduction

Unit IV: Convection

4.1 Physical mechanisms on convection
4.2 Velocity boundary layer, thermal boundary layer
4.3 Laminar and turbulent flows, heat and momentum transfer in turbulent flow
4.4 Derivation of differential convection equations
4.5 Drag force and heat transfer in external flow
4.6 Parallel flow over flat plates, flow across cylinder and spheres, flow across tube banks
4.7 Internal forced convection, laminar and turbulent flow in tubes, General thermal analysis
4.8 Physical mechanism of natural convection
4.9 Equation of motion and the grashof number, natural convection over finned surfaces

Unit V: Fundamental of Thermal Radiation

5.1 Thermal radiation, blackbody radiation
5.2 Radiation intensity, solid angle, intensity of emitted radiation, radiosity
5.3 Radiation properties, emissivity, absorptivity, reflectivity and transmissivity

Unit VI: Heat Exchangers, furnaces and evaporators

6.1 Types of heat exchangers
6.2 The overall heat transfer coefficient, fouling factor
6.3 Analysis of heat exchangers
6.4 Selection of heat exchangers
6.5 Heat transfer in coiled and jacketed agitated vessels
6.6 Furnaces and evaporators working principles

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Çengel, Y. A., (2003), "Heat transfer: a practical approach", McGraw Hill.
2. Theodore, L., (2011), "Heat transfer applications for the practicing engineer", Wiley & Sons
3. Ã–zisik, M. N., Özışık, M. N., (2012), "Heat conduction", 2nd Edition, Wiley & Sons
4. Bergman, L.T., Lavine, A.S., Incropera, F.P., Dewitt, D.P., (2011), "Fundamentals of heat and mass transfer", 7th Edition, Wiley & Sons
5. Bergman, L.T., Lavine, A.S., Incropera, F.P., Dewitt, D.P., (2017), "Incropera's principles of heat and mass transfer", Wiley & Sons
6. Backhurst, Harker, J.R., Richardson, J.F., Coulson, J.M. (2003), "Chemical Engineering: Fluid flow, heat transfer and mass transfer", Vol-I, 6th Edition, Butterworth-Heinemann.
7. Holman J.P., (2002), "Heat Transfer" Tata McGraw Hill.
8. Cengel, Y.A., Ghajar, A.J, (2014), "Heat and mass transfer: fundamentals and applications", McGraw Hill.
9. Kothandaraman, C.P, (2006), "Fundamentals of heat and mass transfer", New Age.

III CHE233 Fluid and Particle Mechanics - I

Course Outlines

- **Title:** Fluid and Particle Mechanics - I
- **Code Number:** CHE 233
- **Semester:** 3rd
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** PHY115
- **Learning Outcomes:**

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

1. Acquire the knowledge of basic concepts regarding the fluid flow.
2. Analyze the problems of compressible/incompressible fluid flow and the mechanisms of fluids motion with the applications of momentum and energy equations.
3. Solve the problems related to fluid flow and its applications.

- **Contents**

Unit I: Introduction to Fluid and Particle Mechanics

1.1 Fluid and its types
1.2 Classification of fluids
1.3 Nature of fluids

Unit II: Fluid statics

2.1 Introduction
2.2 Hydrostatic Equilibrium
2.3 Head of fluid
2.4 Barometric equation
2.5 Hydrostatic equilibrium in centrifugal field
2.6 Applications of Fluid Statics
  2.6.1 Manometers and its types
  2.6.2 Bourdon Gauges and its types
2.7 Continuous gravity decanter
2.8 Centrifugal decanter
2.9 Numerical relevant to theory and its applications

Unit III: Friction in Pipe and Channels

3.1 Shearing characteristics of fluid
3.2 Friction losses through pipes, ducts and fittings
3.3 Piping network analysis

Unit IV: Flow of Compressible Fluids

4.1 Isothermal and non-isothermal flow of an ideal gas in horizontal pipe
4.2 Adiabatic flow of an ideal gas in a horizontal pipe
4.3 Flow of non-ideal gases

Unit V: Flow Measurement

5.1 Pitot tube
5.2 Orifice-meter
5.3 Venturi meter
5.4 Rotameter

5.5 Nozzle
5.6 Notch and Weir
5.7 Magnetic flow meters
5.8 Ultrasonic flow meters

Unit VI: Pumping of Fluid

6.1 Introduction
6.2 Pumping equipment for liquids
6.3 The reciprocating pump
6.4 Positive displacement pumps
6.5 The centrifugal pumps
6.6 Net positive suction head
6.7 Pumping equipment for gases
6.8 Vacuum producing equipment
6.9 Power required for pumping of gases
6.10 Power requirement for pumping through pipe lines

Unit VII: Motion of Particles in Fluid

7.1 Introduction
7.2 Drag force on a spherical particles
7.3 Non spherical particles
7.4 Motion of bubble and drops
7.5 Accelerating motion of a particle in the gravitational field
7.6 Motion of particle in centrifugal field

Unit VIII: Sedimentation

8.1 Sedimentation of fine particles
8.2 Flocculation, the thickener
8.3 Sedimentation of course particles
8.4 Suspensions of uniform particles
8.5 Comparison of sedimentation with flow through fixed beds
8.6 Sedimentation of two component mixtures

Unit IX: Centrifugal Separation

9.1 Introduction
9.2 Shape of free surface of liquid
9.3 Centrifugal pressure
9.4 Separation of immiscible liquids of different densities
9.5 Sedimentation in a centrifugal field
9.6 Centrifugal equipment

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Coulson, J.M., Richardson, J.F., Backhurst, J. R., Harker J. H., (1999), "Chemical Engineering" Vol. I, 6th Edition Butterworth-Heinemann.
2. Coulson, J.M., Richardson, J.F., Backhurst, J. R., Harker J. H., (2006), "Chemical Engineering" Vol. 4, Butterworth-Heinemann.
3. McCabe W.L., Smith J.C., Harriott P. (2001), "Unit Operations of Chemical Engineering" 6th Edition McGraw Hill
4. Daugherty, R. L., Franzini, J. B., Finnemore, E.J., (1989), "Fluid mechanics with engineering applications", McGraw Hill
5. Holland, F., Bragg, R. (1995), "Fluid flow for Chemical Engineers", 2nd Edition, Elsevier.
6. White, F. M. (2000), "Fluid Mechanics", 4th Edition, McGraw Hill
7. Noel de Nevers (2005), "Fluid Mechanics for Chemical Engineers", McGraw Hill
8. Fox, R.W., McDonald, A.T., Pritchard P.J., (2009), "Introduction to Fluid Mechanics", Wiley & Sons.
9. Som, S. K., Biswas, G. , Chakraborty, S . (2017) "Introduction to Fluid Mechanics and Fluid Machines", McGraw Hill.
10. Wilkes J. O., (2018) "Fluid Mechanics for Chemical Engineers: with Microfluidics, CFD, and COMSOL Multiphysics", 3rd Edition, Pearson
11. Green D.W., Perry, R.H, (2007) "Perry's Chemical Engineers Handbook" 8th Edition, McGraw Hill.

IV HUM234 Pakistan Studies

Course Outlines

- **Title: Pakistan Studies**
- **Code Number:** HUM234
- **Semester:** 3rd
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** Intermediate Level
- **Learning Outcomes:**

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

  1. Explain the dynamic changes in the Muslim Era
  2. Explain the major history of Pakistan

- **Contents**

مطالعہ پاکستان

مقاصد:

تحریک پاکستان کا ایسا مطالعہ جس سے طلباء میں ماضی پر فخر، حال کے لئے جوش وخروش اور مستقبل پر مستحکم اعتماد ہو اور ان کا پختہ عقیدہ ہو کہ قومی استحکام اور ملی ترقی کے لئے وہ سب کچھ کرنا فرض ہے کہ جس کے وہ اہل ہیں - تاکہ میرِ وطن کے لئے یہ ایک جذباتی احساس ہی نہ ہو بلکہ نظریہ پاکستان کے علمی تعمیر اور تحریک پاکستان کو صحیح معنوں میں سمجھنے کا نتیجہ ہو

یہ نصاب پاکستانی طلباء کی ذہنی تربیت کا ایسا درسی مواد ہو کہ جو پاکستانی تشخص اپنی روایات پر یقین کو مستحکم بنانے اور عملی زندگی میں ایسے تعمیری رویہ کی جانب رہنمائی کرے کہ جو قوم کو اسلامی اقدار سے قریب تر کرنے میں معاون ہو - مختصراً یہ قومی پالیسی کے نصب العین "پاکستان کے اسلامی نظریہ کو قائم رکھنے، تقویت دینے اور مستحکم کرنا اور علمی تربیت کے ذریعے اس کو انفرادی اور قومی زندگی کا شعار بنانے " کی تفسیر ہو -

باب اول

تحریک پاکستان:

(1) برصغیر میں مسلم دور حکومت
(2) برصغیر میں مسلم معاشرہ کی تشکیل وارتقاء
(3) مسلم اقتدار کا زوال اور نشاۃ ثانیہ کی کوشش

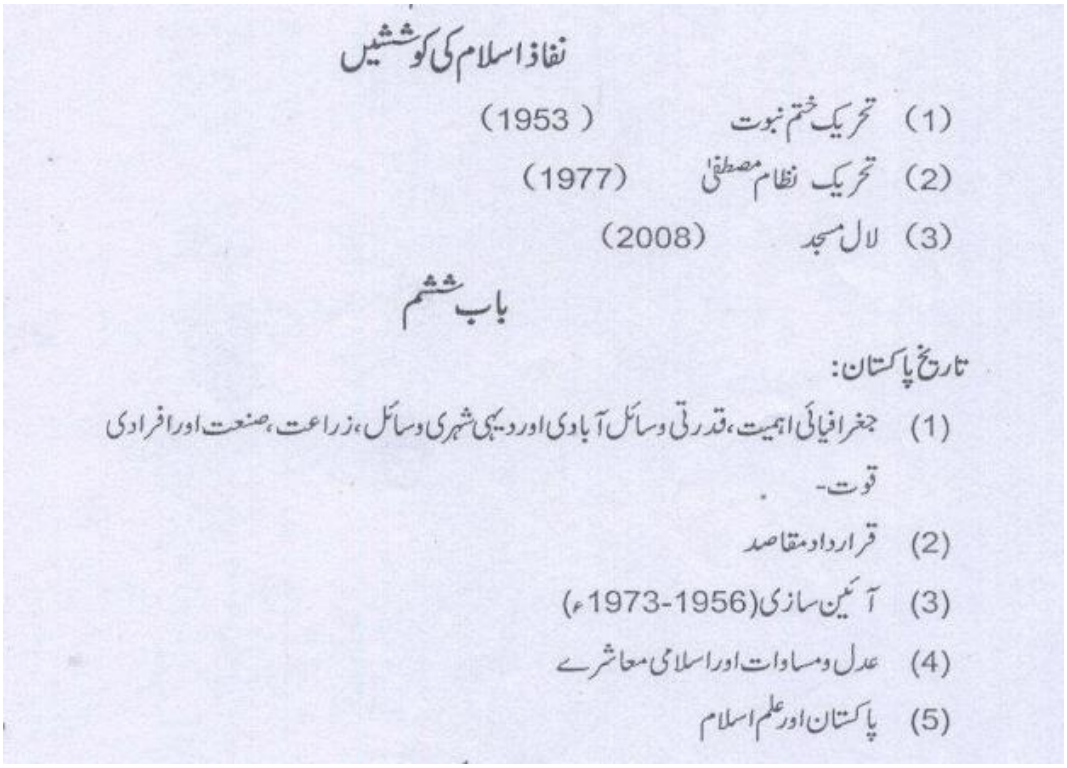
نفاذ اسلام کی کوششیں

(1) تحریک ختم نبوت (1953)
(2) تحریک نظام مصطفیٰ (1977)
(3) لال مسجد (2008)

باب ششم

تاریخ پاکستان:

(1) جغرافیائی اہمیت، قدرتی وسائل آبادی اور دیہی شہری وسائل، زراعت، صنعت اور افرادی قوت-
(2) قرارداد مقاصد
(3) آئین سازی (1956-1973ء)
(4) عدل ومساوات اور اسلامی معاشرے
(5) پاکستان اور علم اسلام



نفاذ اسلام کی کوششیں

(1) تحریک ختم نبوت (1953)

(2) تحریک نظام مصطفیٰ (1977)

(3) لال مسجد (2008)

باب ششم

تاریخ پاکستان:

(1) جغرافیائی اہمیت، قدرتی وسائل آبادی اور دیہی شہری وسائل، زراعت، صنعت اور افرادی قوت۔

(2) قرارداد مقاصد

(3) آئین سازی (1956-1973ء)

(4) عدل و مساوات اور اسلامی معاشرے

(5) پاکستان اور علم اسلام

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Burki, S.M., Ziring, L. (1993), "Pakistan's Foreign policy: An historical analysis". Oxford University
2. Akbar, S. Zaidi, (2000), "Issue in Pakistan's Economy", Oxford University
3. Haq, Noor ul. (1993), "Making of Pakistan: The Military Perspective National Commission on Historical and Cultural Research", Islamabad.
4. Burki, S.J., (1980), "State and Society in Pakistan", Macmillan.
5. Qureshi I.H., (1974), "The struggle for Pakistan", Karachi University.

V MTH235 Engineering Mathematics-III

Course Outlines:

- **Title:** Engineering Mathematics-III
- **Code Number:** MTH235
- **Semester:** 3rd
- **Credit Hours:** 3
- **Pre-requisites course requirements/ skills:** MTH112, MTH123
- **Learning Outcomes:**

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

  1. Apply the properties of vector quantities and 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

- **Contents**

Unit I: Vector Analysis

1.1 Review of vector algebra, Dot and Cross products of vectors with physical interpretation

1.2 Scalar and vector point functions, Scalar triple product, Vector triple product, Physical interpretation with application

1.3 Gradient of a function; Divergence, curl and their physical interpretations

1.4 Gauss's and Green's Theorems

1.5 Orthogonal curvilinear Co-ordinates

Unit II: Linear Algebra:

2.1 Matrix Algebra

2.2 Introduction to Systems of Linear Equations and their solutions

2.3 Direct and Indirect Methods

2.4 Inevitability, Eigen values and eigenvectors of Matrices

2.5 Applications to flow models

2.6 Case studies in chemical engineering

Unit III: Partial Differential Equations

3.1 Classifications of partial differential equations

3.2 Solution of partial differential equations

- 3.2.1 Treating as ordinary differential equations
- 3.2.2 Separation of variables

3.3 Some standard partial differential equations

3.4 Heat, Wave, Laplace Equations (one, two and three dimensions)

3.5 Modeling in chemical engineering

Unit IV: Laplace Transform

4.1 Laplace transform of elementary functions, Laplace transform theorems

4.2 Inverse Laplace transform, Inverse Laplace transform theorems, Convolution

4.3 Laplace transform with derivatives and integrals

4.4 Solution of Differential Equations with the help of Laplace Transforms.

4.5 Application of the Laplace transform

Unit V: Fourier Series

5.1 Basic concepts of Fourier series

5.2 Periodic functions, periodic extensions

5.2.1 Fourier Series of Periodic Functions with Period 2Π

5.2.2 Fourier Series of Periodic Functions with Period 2 L

5.3 Fourier Series of Even and Odd Functions

5.4 Half Range Fourier Sine and Cosine

5.5 Solutions of PDEs using Fourier series

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

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

VI CHE 236 Heat Transfer Lab

Practicals pertaining to the course outlined mentioned in CHE232

VII CHE 237 Fluid and Particle Mechanics-I Lab

Practicals pertaining to the course outlined mentioned in CHE233

VIII CSC238 Computing and Computer Programming Lab

Course Outlines

- **Title:** Computing and Computer Programming Lab
- **Code Number:** CSC238
- **Semester:** 3rd
- **Credit hours**: 1
- **Pre-requisites course requirements/ skills:** Basic knowledge of computers skills
- **Learning Outcomes:**

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

  1. Understand the organization of a computer system.
  2. Understand the process of compiling, linking, and running a program
  3. Prepare the formal lab report
- **Contents**

  Unit I: Introduction

  1.1 Introduction to Computers: CPU, Memory Structures and their addressing
  1.2 I/O devices and data storage devices
  1.3 Computer network basics: logging-in, proper usage, access and security.
  1.4 General features of Microsoft Windows operating.

  Unit II: Word Processing and PowerPoint

  2.1 Document creation and editing
  2.2 Document formatting
  2.3 Use of styles and templates
  2.4 Use of various tools like tables
  2.5 Editing: Equation editing, spelling and grammar checking, page numbering and auto table-of-contents.
  2.6 Introduction to basic features of MS PowerPoint

Unit III: Spreadsheets:

3.1 Data types entry and editing.
3.2 Formatting, inserting, deleting and formatting cells, rows and columns, formula entry and coping
3.3 Use of relative and absolute addresses, paste and paste-special features.
3.4 Use of data analyses tools and built-in functions.
3.5 Arithmetic operations
3.6 Use of charting tools.

Unit IV: Programming

4.1 Introduction to Programming
4.2 C++ History and development of languages
4.3 Elements of a language: instructions, data and addresses
4.4 Syntax and instruction sets
4.5 Variable types: Names and character sets
4.6 Declaration statements
4.7 Format: read, write and print.
4.8 Program structure: Declarations, main program and termination.
4.9 Input and output requirements.
4.10 Use of subroutines and functions.
4.11 Program flow: use of DO loops, IF statements, GOTO and labels.
4.12 Nesting of loops and IF blocks. Structured programming.
4.13 File handing: Editing. Compiling, linking, loading and executing.
4.14 Opening and closing of files.
4.15 Program development: Sequential modular layout. Choice of step length and run time.
4.16 Good practice. C++ and other advanced Computer Languages (MATLAB).

- **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 using computer, multi-media and writing board instructional aids.

  Lab Lectures: 3 contact hours per week
  Software: MS Office (MS word, MS Excel, MS PowerPoint), C++, MATLAB

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

Assessment and Examinations:

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written/Practical examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: lab participation, attendance, assignments and performance on computer.
3.	Final Assessment	40%	Written/Practical examination at the end of semester.

- **Textbooks and reference readings**

1. Sanford, Larry R., Nyhoff, L.,(1996) "Introduction to FORTRAN 90 for Engineers and Scientists", Prentice Hall.
2. Habraken, Joseph W., (2003), "Microsoft Office 2003 All-in-One," Que.
3. Bruce A. Finlayson, (2006) "Introduction to Chemical Engineering Computing". Wiley & Sons.
4. Norton, Peter, (2002), "Introduction to Computers", 5th Edition. Career.

IX HUM300 Quranic Translation

The students will learn Holy Quran with translation in this module. The module is added as per decision of Academic Council.

4Th SEMESTER

I CHE 241 Particulate Technology

Course Outlines

- **Title:** Particulate Technology
- **Code Number:** CHE 241
- **Semester:** 4th
- **Credit hours:** 3
- **Pre-requisites course requirements/skills:** CHE111, CHE121
- **Learning Outcomes:**

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

  1. Understand the fundamental concepts of particle characterization, handling and processing of particulate solids.
  2. Describe the operation of various particle processing equipment.
  3. Comprehend the selection criteria for handling of solids.
  4. Solve particulate technology related problems involving simple analytical and sizing calculations.

- **Contents**

  Unit I: Particle Size Analysis

  1.1 Introduction
  1.2 Describing the size of a single particle
  1.3 Description of the populations of particles
  1.4 Conversion between distributions
  1.5 Common methods of displaying size distributions
  1.6 Methods of particle size measurement

  Unit II: Properties, Handling, Mixing and Segregation of Particulate Solids

  2.1 Characterization of solid particles
  2.2 Mixing mechanism
  2.3 Types of solid mixing machines, operational limitations and benefits
  2.4 Energy consumption and mixing indices
  2.5 Segregation
  2.5.1 Causes and consequences of segregation
  2.5.2 Mechanisms of segregation

2.6 Reduction of segregation
2.7 Assessing the mixture
    2.7.1 Quality of a mixture
    2.7.2 Sampling
    2.7.3 Statistics relevant to mixing
2.8 Storage and flow of powders
    2.8.1 Flow patterns and stress in a hopper and silo
    2.8.2 Flow criterion
    2.8.3 Shear cell test
    2.8.4 Pneumatic transport

Unit III: Particle Size Reduction

3.1 Particle fracture mechanisms
3.2 Energy requirement and principles of mechanical size reduction
3.3 Types of comminution equipment
    3.3.1 Factor affecting size reduction
    3.3.2 Stressing mechanisms
    3.3.3 Material properties
    3.3.4 Carrier medium
    3.3.5 Mode of operation
    3.3.6 Combination with other operations
    3.3.7 Types of milling circuit

Unit IV: Particle Size Enlargement

4.1 Inter-particle forces
4.2 Granulation-agglomeration

Unit V: Flow Past Immersed Bodies

5.1 Motion of particle in fluid
5.2 Forces on a particle moving though a fluid
5.3 Mechanics of particles in a centrifugal field

Unit VI: Solid-Solid Separation, Colloids and Sedimentation

6.1 Types of solid-solid separation equipment
6.2 Physics of precipitation, sedimentation of fine and coarse particles, colloids, solid-water slurries.
    6.2.1 Batch settling, continuous settling, worked examples
    6.2.2 Homogeneous-Heterogeneous slurries, components of a slurry flow system

6.2.3 Sedimentation, sedimentation rate, suspension rheology, influence of surface forces on suspension flow

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Ortega-Rivas E., (2011), "Unit Operations of Particulate Solids- Theory and Practice", Taylor & Francis.
2. Rhodes M., (2008), "Introduction to Particle Technology", Wiley & Sons.
3. Harker, J. H., Backhurst, J. R., Richardson, J. F., (2013), "Chemical Engineering", Vol-II, 5th Edition, Butterworth-Heinemann
4. McCabe, W.L., Smith, J.C., Harriott, P., (2005),"Unit operations of Chemical Engineering". 7th Edition McGraw Hill
5. Holdich R.G., (2002)," Fundamentals of Particle Technology", Midland.
6. Maynard E., (2013), "Ten Steps to an Effective Bin Design", American Institute of Chemical Engineers.
7. Jonathan P.K., Chuan Y.W.,(2016), "Particle Technology and Engineering: An Engineer's Guide to Particles and Powders", Butterworth-Heinemann, Elsevier

II CHE 242 Chemical Engineering Thermodynamics-I

Course Outlines

- **Title:** Chemical Engineering Thermodynamics-I
- **Code Number:** CHE242
- **Semester:** 4th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHEM125
- **Learning Outcomes:**

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

  1. Describe the fundamentals concepts of chemical and engineering thermodynamics.
  2. Understand energy analysis of closed and open systems.
  3. Examine thermodynamic cycles
  4. Analyse energy production systems and refrigeration

- **Contents**

  Unit I: First Law of thermodynamics and Properties of Pure Substances

  1.1 Fundamentals of thermodynamics
  1.2 Intuitive systematic problem-solving technique
  1.3 Constant-property processes, reversible and irreversible processes.
  1.4 Phase diagrams
  1.5 Ideal-gas equation of state and compressibility factor for real gases and the procedures for determining thermodynamic properties
  1.6 Energy analysis of Closed systems including the examination of the moving boundary work and concepts of specific heats, internal energy
  1.7 Enthalpy of ideal gases as well as solids or liquids

  Unit II: Second and third laws of thermodynamics

  2.1 Concept of thermal efficiency
  2.2 The increase of entropy principle, entropy change of pure substances
  2.3 Thermodynamic analysis of steady- flow equipment
  2.4 Concept of energy and its applications

  Unit III: Power refrigeration cycles

  3.1 Vapor and gas power cycles
  3.1.1 Carnot vapor cycle

3.1.2 Rankine cycle
3.1.3 Otto cycle
3.1.4 Diesel cycle
3.1.5 Brayton cycle
3.1.6 Combined gas–vapor power cycles
3.1.7 Reversed Carnot cycle
3.1.8 The ideal vapor-compression refrigeration cycle
3.1.9 Actual vapor-compression refrigeration cycle

3.2 Factors to increase the efficiency of power cycles
3.3 Concepts of refrigerators and heat pumps
3.4 Liquefaction

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbook and reference readings**

1. Cengel, Yunus A., Boles, Michael A. (2019), "Thermodynamics: An Engineering Approach", 9th Edition McGraw Hill

2. Smith J.M., Van Ness H. C., Abbott M.M. (2017), "Chemical Engineering Thermodynamics", 8th Edition McGraw Hill
3. Eastop T. D., McConkey A. (1993), "Applied Thermodynamics for Engineering Technologists" 5th Edition Wiley & Sons
4. Daubert, Thomas E. (1985), "Chemical Engineering Thermodynamics"1st Edition McGraw Hill
5. Koretsky, M., (2004), "Chemical Thermodynamics", Wiley & Sons.

III NEN243 Technical Writing and Communication Skills

Course Outlines

- **Title:** Technical Writing and Communication Skills
- **Code Number:** NEN243
- **Semester:** 4th
- **Credit hours:** 3
- **Pre-requisites course:** NEN113
- **Learning Outcomes:**

  Upon successful completion of the course, the students will be able to:
  1. Write essays, technical, and Laboratory reports.
  2. Communicate thoughts and ideas in a cogent and coherent way.
  3. Prepare presentations and notes of meetings.
- **Contents**

  Unit I: Technical Report Writing

  1.1 Essay writing
  1.2 Preparation of laboratory and other technical reports
  1.3 Logical presentation of facts and opinion in technical reports
  1.4 Transformation of sentences
  1.5 Synthesis
  1.6 Idioms
  1.7 Use of punctuation in English Composition
  1.8 Substitution of words
  1.9 Common mistakes and difficulties faced by the students
  1.10 Use of English Language Laboratory

  Unit II: Communication Skills

  2.1 Importance of effective communication

2.2 The process and principles of communication
2.3 Planning organizing
2.4 Editing before communication
2.5 Letter and memos
2.6 Direct requests
2.7 Persuasive requests favorable/unfavorable replies
2.8 Special message
2.9 Preparation and presentation of reports
2.10 Analytical reports
2.11 Informational reports
2.12 Monthly/annual reports
2.13 Conference reports
2.14 Progress proposals reports
2.15 Formal reports
2.16 Project reports
2.17 Oral communication
2.18 Business meetings
2.19 Interpersonal and non-written communication
2.20 Modern office technology for communication
2.21 Social and intercultural communication

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written examination at the mid-point of the semester.

2.	Formative Assessment	25%	It includes: classroom participation, attendance and assignments.
3.	Final Assessment	40%	Written examination at the end of semester.

- **Textbooks and reference readings**

1. Bough L.S. (1999), "How to write first class letters", NTE.
2. Day, R.A. (2006), "How to write and publish a scientific paper" 6th Edition, Cambridge University.
3. Beer, D., McMurrey, D. (2009), "A Guide to Writing as an Engineer" 3rd Edition, Wiley & Sons
4. Ficco, M. (2008), "What Every Engineer should know about Carrier Management" Taylor & Francis.
5. Thomas, A. J., Martinent, A.V, (1986), "Practical English Grammar", 3rd Edition, Oxford University.

IV CHE244 Fluid and Particle Mechanics - II

Course Outlines

- **Title:** Fluid and Particle Mechanics - II
- **Code Number:** CHE244
- **Semester:** 4th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** PHY115
- **Learning Outcomes:**

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

  1. Describe particles and systems of particles
  2. Understand the flow behaviour of particles
  3. Familiarize with the unit operations in particle separation, solid-liquid separation, fluidization and flow through packed beds.
  4. Solve problems related to the unit operations associated with pharmaceuticals and minerals processing industries

- **Contents**

  Unit I: Flow of fluids through granular beds and packed columns

  1.1 Introduction

1.2 Flow of a single fluid through a granular bed
1.3 Dispersion
1.4 Packed Columns

Unit II: Fluidization

2.1 Introduction
2.2 Characteristics of fluidized systems
2.3 Liquid-solids systems
2.4 Gas-solids systems
2.5 Gas-liquid-solids fluidized beds
2.6 Applications of the fluidized solids technique
2.7 Gas cleaning equipment

Unit III: Liquid Filtration

3.1 Introduction
3.2 Filtration theory
3.3 Filtration practice
3.4 Filtration equipment

Unit IV: Liquid Mixing

4.1 Introduction
4.2 Mixing mechanism
4.3 Scale-up of stirred vessels
4.4 Power consumption in stirred vessels
4.5 Flow pattern in stirred vessels
4.6 Rate and time of mixing
4.7 Mixing equipment

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

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

- **Textbooks and reference readings**

1. Harker, J. H., Backhurst, J. R., Richardson, J. F., (2013), "Chemical Engineering", Vol-II, 5th Edition, Butterworth-Heinemann
2. Backhurst, J. R., Harker, J. H., , Richardson, J. F., Coulson, J.M. (1999), "Chemical Engineering", Vol-I, 6th Edition, Butterworth-Heinemann
3. McCabe W.L., Smith J.C., Harriott P. (2005), "Unit Operations of Chemical Engineering" 7th Edition, McGraw Hill
4. Daugherty, Robert L., Franzini, Joseph B., Finnemore, E.John (1989), "Fluid mechanics with engineering applications", McGraw Hill
5. Holland, F.A., Bragg, R. (1995), "Fluid flow for Chemical Engineers", 2nd Edition Butterworth-Heinemann
6. White, F. M. (1999), "Fluid Mechanics", 4th Edition, McGraw Hill
7. Noel de Nevers (2004), "Fluid Mechanics for Chemical Engineers", 3rd Edition McGraw Hill
8. Pritchard, Philip J., Mitchell, John W. (2016) "Fox and McDonald's Introduction to Fluid Mechanics", 9th Edition, Wiley
9. Som, S K., Biswas, Gautam , Chakraborty, S . (2017) "Introduction to Fluid Mechanics and Fluid Machines", McGraw Hill.
10. Wilkes James O. (2018) "Fluid Mechanics for Chemical Engineers: with Microfluidics, CFD, and COMSOL Multiphysics", 3rd Edition, Pearson

V CHE 245 Particulate Technology Lab

Practicals pertaining to the course outlined in CHE241

VI CHE 246 Fluid and Particle Mechanics-II Lab

Practicals pertaining to the course outlined in CHE244

VII CHE247 Computer Applications in Chemical Engineering Lab

Course Outlines

- **Title:** Computer Applications in Chemical Engineering Lab
- **Code:** CHE247
- **Semester:** 4th
- **Credit hours:** 1
- **Pre-requisites course requirements/ skills:** Basic knowledge of computer skills
- **Learning Outcomes:**

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

  1. Illustrate the use of MS Excel, Origin, MATLAB and Aspen Hysys to solve simple mathematical operations.
  2. Apply basic feature of MS Excel, Origin, MATLAB and Aspen Hysys to solve chemical engineering problems such as physical properties estimation and simulation of unit operations.

- **Contents**

  Unit I: Use of Excel and Origin Data Analysis and Graphic software

  1.1 Introduction to software interface
  1.2 Linear algebra applications in Excel
  1.3 Plotting of various types of graphs in Excel
  1.4 Curve fitting and regression analysis, solver tool in Excel
  1.5 Introduction to Origin (Data Analysis and Graphic software)
  1.6 Plotting, regression analysis and Statistical analysis in Origin

  Unit II: Use of MATLAB and Aspen Hysys

  2.1 Linear algebra applications, Eigen value calculations in MATLAB
  2.2 Building new functions and making interactions and loops in MATLAB
  2.3 Solution of differential equations in MATLAB using Euler, improved Euler and Range Kutta methods
  2.4 Plotting in MATLAB using programming or built-in functions
  2.5 Curve Fitting and Regression analysis in MATLAB
  2.6 Numerical solution/calculation of integrals, derivatives, ODEs and PDEs in MATLAB
  2.7 Symbolic mathematics in MATLAB: symbolic differentiation and solution of differential equations

2.8 Introduction to Simulink (MATLAB)
2.9 Introduction to Simulation Software Aspen Hysys
2.10 Applications of Aspen Hysys in material and energy balance

- **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.

  Lectures: 3 contact hours per week
  Software: MS Excel, Origin, MATLAB, AspenOne

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written/Practical examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: lab participation, attendance, assignments and performance on computer.
3.	Final Assessment	40%	Written/Practical examination at the end of semester.

- **Textbooks and reference readings**

1. Finlayson, Bruce A. (2012), "Introduction to Chemical Engineering Computing", Wiley & Sons
2. Timothy A., K. S. (2004), "Matlab Primer", 7th Edition, CRC.
3. Loney, N.W (2001) "Applied Mathematical methods for Chemical Engineers" CRC.
4. Ronald B. G., Kharab, Abdel W.,(2001), "An introduction to Numerical Methods", CRC.
5. Ghasem, N. (2011)"Computer Methods in Chemical Engineering", CRC.
6. Yeo ,Yeong K., (2017) "Chemical Engineering Computation with MATLAB", CRC.

5TH SEMESTER

I CHE 351A Environmental Engineering

Course Outlines

- **Title:** Environmental Engineering
- **Code Number:** CHE 351A
- **Semester:** 5th
- **Credit hours:** 2
- **Pre-requisites Course:** Basic understanding of applied chemistry and mathematics
- **Learning Outcomes:**

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

  1. Understand the Environmental Pollution.
  2. Comprehend the Air Pollution and its control by using different equipment.
  3. Acquire the knowledge of effluents and waste water treatment processes.
  4. Solve problems related to solid waste management and Environmental Management Systems.

- **Contents**

  Unit I: Air Pollution and Control

  1.1 Nature and sources of air pollutants
  1.2 Objectives of sampling and monitoring program
  1.3 Design of industrial particulate capture systems using cyclones
  1.4 Electrostatic precipitators
  1.5 Filters
  1.6 Scrubbers
  1.7 Design of organic compound emissions control using incineration
  1.8 Bio filtration
  1.9 Adsorption and absorption
  1.10 Overview of NOx and SOx control
  1.11 Indoor air quality assessment techniques

  Unit II: Effluents and Waste Water treatment

  2.1 Industrial waste water sampling and characterization
  2.2 Primary Treatment
  - 2.2.1 Screening
  - 2.2.2 Flow equalization

2.2.3 Sedimentation
2.2.4 Precipitation
2.2.5 Coagulation and Flocculation
2.2.6 Floatation
2.2.7 Filtration and other operations involved in effluent treatment

2.3 Secondary Treatment
2.3.1 Overview of biological waste water treatment
2.3.2 Kinetics of biological growth
2.3.3 Aerobic treatment processes

2.4 Advanced Treatment Methods

Unit III: Solid Waste Management

3.1 Introduction to Solid Waste Management

Unit IV: Principles and purposes of IEE and EIA

4.1 Cost and benefits of EIA
4.2 Main stages in EIA process
4.3 Public consultation and participation in EIA process
4.4 EIA methods and techniques for impact prediction and evaluation

Unit V: Introduction to Environmental Management System

5.1 ISO 14001
5.2 Aspect and impact Analysis
5.3 Legal and statutory requirements for Environmental Management System

- **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.

Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

A minimum of two assignments to be submitted before the written exam of final Term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Cheremisinoff, N. P. (2002), "Handbook of air pollution prevention and control", Elsevier
2. Eckenfelder, W. W., (2000), "Industrial Water Pollution Control", McGraw Hill
3. Bishop, P. L. (2000), "Pollution prevention: fundamentals and practice", Waveland.
4. Cheremisinoff, N. P., (2001), "Handbook of pollution prevention practices". CRC.

I CHE351B Natural Gas Engineering –I

Course Outlines

- **Title:** Natural Gas Engineering - I
- **Code Number:** CHE351B
- **Semester:** 5th
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** Basic understanding of physical chemistry and mathematics.
- **Learning Outcomes:**

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

  1. Acquire knowledge of occurrence, commercial uses, composition and properties of natural gas.
  2. Apply engineering knowledge to solve problems related to natural gas exploration, production and processing
- **Contents**

  Unit I: Introduction

1.1 Occurrence of natural gas, indigenous and world N.G. reserves and production
1.2 Introduction to natural gas industry
    1.2.1 N.G. as domestic, commercial, industrial fuel and as raw material for downstream petrochemical industry.
1.3 Constituents of natural gas and compositions of gases from various fields of the country

Unit II: Gas Properties

2.1 Physical, chemical, thermal, thermodynamic and transport properties of natural gas
2.2 Gas laws, PVT correlations and equations of state
2.3 Use of compressibility factor charts
2.4 Prediction of properties of gaseous mixtures.

Unit III: Exploration/Prospecting

3.1 Petroleum Geology: Types and geological characteristics of sedimentary rock structures
3.2 Geosynclines and types of traps
3.3 Geological, geophysical, geochemical methods of exploration
3.4 Types of natural gas reserves and gas reserves terminologies

Unit IV: Drilling and Production

4.1 Methods of drilling
4.2 Rotary drilling
4.3 Drilling rig
4.4 Characteristics of drilling fluid or mud, well completion, logging and testing
4.5 Oil and gas separators
4.6 Flare lines and other field equipment needed for production and field gas gathering systems.

Unit V: Gas Conditioning and Processing

5.1 Gas cleaning principles, methods and equipment
5.2 Introduction to various absorption, adsorption and chemical conversion gas purification processes
5.3 Gas hydrates and their prevention
5.4 Gas purification techniques
5.5 Sulphur recovery from sour natural gas
5.6 Recovery of LPG from N.G.
5.7 Recovery of helium from N.G.

5.8 New trends in gas purification.

- **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.

  Lectures: 2 hours per week.

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Speight, J. G. (2015), "Handbook of petroleum product analysis", 2nd Edition Wiley & Sons
2. Hilyard, J. (2012), "The oil and gas industry: A nontechnical guide",PennWell Books
3. Lyons, W., Plisga, G. J. (2005), "Standard Handbook of Petroleum and. Natural Gas Engineering", 3rd Edition, Gulf.
4. Kerry, F. G. (2007), "Industrial gas handbook: gas separation and purification", CRC.
5. Kohl, A. L., Nielsen, R. (1997), "Gas purification",5th Edition Elsevier
6. Kidnay, A. J., Parrish, W. (2006), "Fundamentals of natural gas processing", CRC.

I CHE 351C Nuclear Engineering

Course Outlines

- **Title:** Nuclear Engineering

- **Code Number:** CHE 351C
- **Semester:** 5th
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** Basic understanding of chemistry and mathematics.
- **Learning Outcomes**

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

  1. Understand the fundamentals of steady state and time dependent nuclear reactor theory.
  2. Comprehend the basics of heat generation and removal from reactor cores.

- **Contents**

  Unit I: Fundamentals of Nuclear Engineering

  1.1 Introduction
  1.2 Radioactivity
  1.3 Nuclear sections
  1.4 Nuclear Fission and chain reaction
  1.5 Conversion and breading

  Unit II: Nuclear Reactors

  2.1 Reactor components and their characteristics
  2.2 Production and power reactors
  2.3 Introduction to fast and fusion reactor systems
  2.4 Heat generation and removal from reactor cores

  Unit III: Nuclear Fuels

  3.1 Different types of fuel cycles
  3.2 Uranium enrichment
  3.3 Fabrication of fuel
  3.4 Reprocessing of Irradiated fuel
  3.5 Fuel cycle performance of commercially available reactors

- **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.

Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

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

- **Textbooks and reference reading**

1. Lamarsh, J. R., Baratta, A. J., (2001), "Introduction to nuclear engineering", Vol. 3. Prentice Hall
2. Joyce, M., (2017), "Nuclear Engineering: A Conceptual Introduction to Nuclear Power", Butterworth-Heinemann
3. Lewis, B. J., Onder, E. N., Prudil, A. A. (2017), " Fundamentals of nuclear engineering", Wiley & Sons
4. Stacey W.M., (2007), "Nuclear Reactor Physics", 2nd Edition Wiley & Sons

II CHE352 Chemical Engineering Thermodynamics-II

Course Outlines

- **Title:** Chemical Engineering Thermodynamics-II
- **Code Number:** CHE352
- **Semester:** 5th
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** CHEM125
- **Learning Outcomes:**

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

  1. Understand the phase equilibria and fugacity in the vapour phase, fugacity and activity coefficient in the liquid phase.

2. Comprehend types of equilibrium, fundamental property relation, the chemical potential and phase equilibria, partial properties, and excess properties.
3. Solve the thermodynamics properties and phase equilibria problems.

- **Contents**

Unit I: Equations of State and Intermolecular Forces

1.1 Introduction
1.2 Intermolecular Forces, Internal (Molecular) Energy
1.3 Equations of State
1.4 Generalized Compressibility Charts
1.5 Determination of Parameters for Mixtures

Unit II: Phase Equilibria I: Problem Formulation

2.1 Introduction
2.2 Pure Species Phase Equilibrium
2.3 Roles of Energy and Entropy in Phase Equilibria
2.4 Pure Component Vapor–Liquid Equilibrium: The Clausius–Clapeyron Equation
2.5 Thermodynamics of Mixtures
2.6 The Gibbs–Duhem Equation
2.7 Property Changes of Mixing

Unit III: Multicomponent Phase Equilibria

3.1 The Chemical Potential—The Criteria for Chemical Equilibrium
3.2 Vapor–Liquid Equilibrium (VLE)
3.3 Fitting Activity Coefficient Models with VLE Data
3.4 Vapor–Liquid Equilibrium Using the Equations of State Method
3.5 Liquid —Liquid Equilibrium: LLE
3.6 Vapor–Liquid — Liquid Equilibrium: VLLE
3.7 Solid–Liquid and Solid–Solid Equilibrium: SLE and SSE

Unit IV: Chemical Reaction Equilibria

4.1 Thermodynamics and Kinetics
4.2 Chemical Reaction and Gibbs Energy
4.3 Equilibrium for a Single Reaction
4.4 Calculation of K from Thermochemical Data
4.5 Relationship Between the Equilibrium Constant and the Concentrations of Reacting Species

4.6 The Equilibrium Constant for a Heterogeneous Reaction

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar:**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

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

- **Textbooks and reference readings**

1. Smith J.M., Van Ness H. C., Abbott M.M. (2001), "Introduction to Chemical Engineering Thermodynamics", 6th Edition, McGraw Hill.
2. Koretsky M. (2004), "Engineering and Chemical Thermodynamics", Wiley & Sons.
3. Suslick, K. S. (1999). "Kirk-Othmer Encyclopaedia of Chemical Technology", Wiley & Sons.

III CHE353 Mass Transfer

Course Outlines

- **Title:** Mass Transfer
- **Code Number:** CHE353
- **Semester:** 5th

- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHEM125
- **Learning Outcomes:**

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

  1. Understand the principles of diffusive, convective and inter-phase mass transfer.
  2. Calculate diffusivities and mass transfer coefficients; and understand their significance
  3. Analyze problems involving diffusive and convective mass transfer in one phase and two phase systems.
  4. Solve problems related to stage-wise and continuous contact differential processes.

- **Contents**

  Unit I: Basics of Mass Transfer

  1.1 Introduction to mass transfer
  - 1.1.1 Mechanical and concentration driven processes
  - 1.1.2 Application of mass transfer principles
  - 1.1.3 Concept of mass transfer by molecular and turbulent motion

  Unit II: Diffusion

  2.1 Diffusion in binary gas mixtures
  - 2.1.1 Mass transfer concentrations, velocities and fluxes
  - 2.1.2 Fick's law of diffusion
  - 2.1.3 Maxwell's law of diffusion
  - 2.1.4 Diffusive laws of mass, heat and momentum transport

  2.2 Principles of diffusive mass transfer
  - 2.2.1 Mass transfer through a stationary second component
  - 2.2.2 Equimolar counter diffusion

  Unit III: Diffusivities

  3.1 Diffusivities of liquids, gases and solids
  - 3.1.1 Experimental determination of diffusivities
  - 3.1.2 Prediction of diffusivities

  Unit IV: Convective mass transfer

  4.1 Introduction
  - 4.1.1 Mass transfer coefficients

4.2 Mass transfer across phase boundary
    4.2.1 Two film theory
    4.2.2 Penetration theory
    4.2.3 Surface renewal theory
4.3 Dimensionless groups in mass transfer
4.4 Dimensional analysis of free and forced convective mass transfer.

Unit V: Countercurrent mass transfer

5.1 Introduction
    5.1.1 Stage-wise processes
    5.1.2 Continuous differential contact processes
5.2 Mass transfer and chemical reaction
5.3 Mass transfer to pipes and cylinders, mass transfer to particles

Unit-VI: Absorption of gases

6.1 Introduction
6.2 Conditions of equilibrium between gas and liquid
6.3 The mechanism of absorption
6.4 Experimental measurement of mass transfer coefficients
    6.4.1 Wetted wall columns
    6.4.2 Packed columns
    6.4.3 Spray columns
6.5 Operating line equations for continuous contact towers
    6.5.1 Counter-current flow
    6.5.2 Co-current flow
6.6 Continuous contact equipment analysis

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final Term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Coulson, J. M., Richardson, J. F., Backhurst, J. R., Harker, J. H. (2002), "Chemical Engineering", Vol-II, 5th Edition, Butterworth-Heinemann
2. Coulson J. M., Richardson J. F. (1999), "Chemical Engineering" Vol-I, 6th Edition, Butter Worth-Heinemann
3. McCabe, W.L., Smith, J.C., Harriott, P., (2005),"Unit operations of Chemical Engineering", 7th Edition McGraw Hill
4. Basmadjian, D. (2007), " Mass Transfer and Separation Process: Principles and Applications'',2nd Edition, Taylor & Francis
5. Incropera F.P., De Witt, D. P. (2002), "Fundamentals of Heat and Mass Transfer", 5th Edition, John Willey & Sons
6. Welty, J.R., Wicks, C.E., Wilson, R.E., Rorrer, G.L. (2007), ''Fundamentals of Momentum, Heat and Mass Transfer'', 5th Edition Wiley & Sons.
7. Perry, R.H., Green, D.W (2007) "Perry's Chemical Engineers' Handbook", 8th Edition, McGraw Hill

IV CHE354 Separation Processes-I

Course Outlines

- **Title:** Separation Processes - I
- **Code Number:** CHE354
- **Semester:** 5th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHE232
- **Learning Outcomes:**

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

1. Understand different separation processes and their characteristics with regards to applications
2. Perform economic and sensitivity analyses during the selection of equipment design
3. Interpret problems by presenting a flowchart of the system indicating information and solution to the problems
4. Select the processes to accomplish a desired separation and purification

- **Contents**

Unit I: Evaporation

1.1 Introduction
1.2 Heat transfer in evaporators
1.3 Single-effect evaporators
1.4 Multiple-effect evaporators
1.5 Improved efficiency in evaporation
1.6 Evaporator operation
1.7 Equipment for evaporation

Unit II: Crystallization

2.1 Introduction
2.2 Characteristics of crystals
2.3 Crystallization processes
2.4 Mechanism of crystallization
2.5 Factors effecting crystallization
2.6 Equipment for crystallization
2.7 Importance and application of crystallization

Unit III: Humidification and Water Cooling

3.1 Introduction
3.2 Humidification terms
3.3 Humidity data for the air-water system
3.4 Determination of humidity
3.5 Humidification and Dehumidification
3.6 Water cooling

Unit IV: Drying

4.1 Introduction
4.2 General principles
4.3 Rate of drying
4.4 Drying equipment
4.5 Drying of gases

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Seader, J. D., Henley, Ernest. J., Roper, D. Keith (2010), "Separation Process Principles", 3rd Edition Wiley
2. King, C. J. (2013), "Separation Processes", 2nd Editions, Dover Publications
3. Treybal, R. E.(1980), "Mass Transfer Operations", 3rd Edition McGraw Hill
4. Harker, J. H., Backhurst, J. R., Richardson, J. F., (2013), "Chemical Engineering", Vol-II, 5th Edition, Butterworth-Heinemann
5. Backhurst, J. R., Harker, J. H., , Richardson, J. F., Coulson, J.M. (1999), "Chemical Engineering", Vol-I, 6th Edition, Butterworth-Heinemann
6. McCabe, W.L., Smith, J.C., Harriott, P., (2005),"Unit operations of Chemical Engineering". 7th Edition McGraw Hill
7. Richard Baker, (2004),"Membrane Technology and Applications", 2nd Edition Wiley
8. Wankat, Phillip C. (2012), "Separation Process Engineering: Includes Mass Transfer Analysis" Prentice Hall
9. De Haan, André B. , Bosch, H. (2013) "Industrial Separation Processes Fundamentals", De Gruyter

V GEC355 Engineering Materials

Course Outlines

- **Title:** Engineering Materials
- **Code Number:** GEC355
- **Semester:** 5th
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** Basic understanding of chemistry and thermodynamics
- **Learning Outcomes:**

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

  1. Understand the concepts related to the properties of materials, fabrication techniques and corrosion.
  2. Interpret the equilibrium state, composition and the amount of phase present in the alloys using Phase Diagram.
  3. Select materials for engineering applications.
  4. Solve corrosion related problems.

- **Contents**

  Unit I: Introduction to Materials

  1.1 Historical Perspective
  1.2 Classification of Materials
  1.3 Advance Materials

  Unit II: Atomic Structure and Interaction Bonding

  2.1 Atomic Structure
  2.2 Atomic bonding in solids
  2.3 Imperfection in solids

  Unit III: Phase Diagram

  3.1 Introduction
  3.2 Equilibrium Phase diagram
  - 3.2.1 Binary Isomorphous System
  - 3.2.2 Binary Eutectic System

  Unit IV: Metal Alloys

  4.1 Ferrous Alloys
  4.2 Non-Ferrous Alloys

4.3 Fabrication techniques of Metals

Unit V: Corrosion and Degradation of Materials

5.1 Introduction
5.2 Corrosion rates
5.3 Prediction of corrosion rates
5.4 Environmental effects
5.5 Forms of corrosion and corrosion prevention

Unit VI: Advance Materials

6.1 Polymeric materials
6.2 Composites
6.3 Ceramics
6.4 Bio materials
6.5 Advance Coatings System

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Srivastava C.M., Srinivasan C. (2000) "Science of Engineering Materials" 2nd Edition New Age.
2. Flinn, R. A., Trojan, P. K. (1994) "Engineering Materials and Their Applications" 4th Edition Wiley & Sons
3. Khan, I.H. (1989), "Corrosion Technology", Vol. I and 2, Institute of Chemical Engineering & Technology, University of the Punjab, Lahore Pakistan
4. Farag M.M., (2007), "Materials and Process Selection for Engineering Design", 2nd Edition, CRC.
5. William D. C. Jr., (2002), "Materials Science and Engineering", 6th Edition, Wiley & Sons

VI CHE356 Chemical Reaction Engineering

Course Outlines

- **Title:** Chemical Reaction Engineering
- **Code Number:** CHE356
- **Semester:** 5th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHE122, CHE231
- **Learning Outcomes:**

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

  1. Understand the chemical reaction engineering related terminologies.
  2. Develop the rate equation with concentration and time data using integral and differential methods.
  3. Apply the performance equations to design ideal batch and flow reactors for homogeneous and heterogeneous systems.
  4. Evaluate the combination of reactors' system to minimize the volume.
- **Contents**

  Unit I: Introduction to Chemical Reaction Engineering

  1.1 Concept of chemical reaction engineering
  1.2 Terminologies used in chemical reaction engineering

  Unit II: Kinetic data interpretation

  2.1 Kinetics of homogeneous reaction
  2.2 Variables affecting the rate of reaction
  2.3 Order and mechanism of reaction
  2.4 Activation energy and temperature dependency

2.5 Interpretation of constant and variable volume batch reactor data
2.6 Integral method and differential methods of analysis for constant and variable volume batch reactors to develop rate equation
2.7 Concept of half-life /fractional life.
2.8 Empirical rate equation for nth order reactions.
2.9 Over all order of irreversible reactions
2.10 Reversible and irreversible reactions in parallel

Unit III: Design of Ideal homogeneous reactors

3.1 Ideal isothermal reactors
  3.1.1 Batch reactors
  3.1.2 Mixed Flow reactors
  3.1.3 Plug Flow reactors
3.2 Plug flow reactors in series/parallel
3.3 Equal and different size of mixed reactors in series and parallel
3.4 Design of reactors for multiple reactions, parallel and series reactions.
3.5 Optimum reactor size
3.6 Concept of Recycle reactors

Unit IV: Heterogeneous reactors

4.1 Introduction
4.2 Rate equation for surface kinetics
4.3 Performance equation for reactors containing porous catalyst
4.4 Design of steady state packed bed reactors
4.5 AspenOne and Chemkin applications in reaction engineering

- **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.

  Lectures: 3 hours per week

  Software: ChemKin, AspenOne (reaction module)

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Fogler, H.S. (2016), "Elements of chemical reaction engineering", 5th Edition Prentice Hall
2. Levenspiel, O. (1999), "Chemical reaction engineering", 3rd Edition, Wiley & Sons.
3. Froment, G.F., Bischoff, K.B.; De Wilde, J. (2011), "Chemical reactor analysis and design". 3rd Edition, Wiley & Sons
4. Ross J.R.H. (2012), "Heterogeneous Catalysis: Fundamentals and Applications", Elsevier
5. Nauman E.B. (2018), "Chemical Reactor Design, Optimization, and Scale-up". 2nd Edition, Wiley & Sons.
6. Hill Jr. C.G., Root T.W.,(2014), "Introduction to Chemical Engineering Kinetics and Reactor Design", 2nd Edition Wiley
7. Smith, J.M. (1981), "Chemical engineering kinetics", 3rd Edition McGraw Hill.

VII CHE 357 Separation Processes-I Lab

Practicals pertaining to the course outlined in CHE354

VIII CHE 358 Chemical Engineering Thermodynamics Lab

Practicals pertaining to the course outlined in CHE242 and CHE352

IX CHE 359 Chemical Reaction Engineering Lab

Practicals pertaining to the course outlined in CHE356

X HUM500 Quranic Translation

The students will learn Holy Quran with translation in this module. The module is added as per decision of Academic Council.

6TH SEMESTER

I MGT361 Entrepreneurship

Course Outlines

- **Title:** Entrepreneurship
- **Code Number:** MGT361
- **Semester:** 6th
- **Credit Hours:** 2
- **Pre-requisites course requirements/ skills:** Basic knowledge of business and economics
- **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 startup
  3. Devise a business strategy and businesses plan

- **Contents**

  Unit I: Introduction

  1.1 The concept of entrepreneurship
  1.2 The economist view of entrepreneurship
  1.3 The sociologist view; behavioral approach
  1.4 Entrepreneurship and Management

  Unit II: The Practice of Entrepreneurship

  2.1 The process of entrepreneurship
  2.2 Entrepreneurial Management
  2.3 The entrepreneurial business
  2.4 Entrepreneurship in service institutions The new venture.

  Unit III: Entrepreneurship and Innovation

  3.1 The innovation concepts; Importance of innovation for entrepreneurship
  3.2 Sources of innovative opportunities
  3.3 The innovation process; Risks involved in innovation.
  3.4 Technoprenuership

Unit IV: Developing Entrepreneur

4.1 Entrepreneurial profile
4.2 Trait approach to understanding entrepreneurship
4.3 Factors influencing entrepreneurship
4.4 The environment; Socio cultural factors; Support systems

Unit V: Entrepreneurship Organization

5.1 Team work
5.2 Networking organization
5.3 Motivation and compensation
5.4 Value system

Unit VI: Entrepreneurship and SMES:

6.1 Defining SMEs and Scope of SMEs
6.2 Entrepreneurial managers of SME
6.3 Financial and marketing problems of SMEs

Unit VII: Entrepreneurial Marketing:

7.1 Framework for developing entrepreneurial marketing
7.2 Devising entrepreneurial marketing plan
7.3 Entrepreneurial marketing strategies; Product quality and design.

Unit VIII: Entrepreneurship and Economic Development:

8.1 Role of entrepreneur in the economic development generation of services
8.2 Employment creation and training, Ideas, knowledge and skill development; The Japanese experience
8.3 Case Studies of Successful Entrepreneurs
8.4 Entrepreneurship for Engineers

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Burns, P. (2001), "Small Business and Entrepreneurship", 8th Edition, Palgrave
2. Uchino, K. (2010), "Entrepreneurship for Engineers" ,Taylor & Francis
3. Naude, W. (2010) "Entrepreneurship and Economic Development", Palgrave Macmillan.
4. Drucker, P.F. (2007), "Innovation and Entrepreneurship", Routledge
5. Miner, J.B. (1996) "4 Routes to Entrepreneurial Success", Berrett Koehler.

II CHE 362 Separation Process-II

Course Outlines

- **Title:** Separation Processes-II
- **Code Number:** CHE362
- **Semester:** 6th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHE232
- **Learning Outcomes:**

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

  1. Explain key concepts of separation processes including equilibrium stages, reflux, countercurrent contacting, stage wise and differential contacting, efficiency etc.

2. Select appropriate separation technique for intended problem
3. Solve design problems of separation processes

- **Contents**

Unit I: Distillation

1.1 Introduction
1.2 Vapour-Liquid Equilibrium
  1.2.1 Partial Vaporization and Partial condensation
  1.2.2 Partial Pressure, Dalton's, Raoult's and Henry's Laws
  1.2.3 Relative volatility
1.3 Methods of distillation
  1.3.1 Differential distillation
  1.3.2 Flash distillation
  1.3.3 Rectification
1.4 The fractionating column
  1.4.1 Number of plates required in a distillation column
  1.4.2 Lewis-Sorel method
  1.4.3 McCabe and Thiele method
  1.4.4 The equation of q-line
1.5 The importance of reflex ratio
  1.5.1 Calculation of the minimum reflex ratio
  1.5.2 Underwood and Fenske equations
  1.5.3 Selection of economic reflex ratio
1.6 Conditions for varying overflow in non-ideal binary systems
  1.6.1 Determination of the number of plates on H-x diagram
1.7 Batch distillation
  1.7.1 Operation at constant product composition
  1.7.2 Operation at constant reflex ratio
1.8 Azeotropic and Extractive distillation
1.9 Steam distillation
1.10 Plate efficiency

Unit II: Liquid- Liquid Extraction

2.1 Introduction
2.2 Extraction processes
  2.2.1 Rate of extraction
  2.2.2 Equilibrium data and Triangular diagrams
  2.2.3 Selection criteria of solvent
2.3 Calculation of the number of theoretical stages
  2.3.1 Co-current contact with partially miscible solvents
  2.3.2 Co-current contact with immiscible solvents

2.3.3 Countercurrent contact with immiscible solvents
2.3.4 Countercurrent contact with partially miscible solvents

2.4 Continuous extraction in columns
2.4.1 Capacity of a column operation as continuous counter-current unit

2.5 Classification of extraction equipment
2.5.1 Stage-wise equipment for extraction
2.5.2 Differential contact equipment for extraction

Unit III: Leaching

3.1 Introduction
3.2 Equipment for leaching
3.3 Principles of continuous counter-current leaching
3.4 Calculation for the number of ideal stages

Unit IV: Adsorption

4.1 Adsorbents
4.2 Adsorption processes and equipment
4.3 Adsorption isotherms
4.4 Structure of adsorbents
4.5 Adsorber design

Unit V: Membrane Separation

5.1 Classification of membrane processes
5.2 Nature of synthetic membranes
5.3 General membrane equation
5.4 Reverse osmosis
5.5 Gas separation
5.6 Pervaporation
5.7 Electrodialysis

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

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

- **Textbooks and reference readings**

1. Coulson, J. M., Richardson, J. F., Backhurst, J. R., Harker, J. H. (2002), "Chemical Engineering", Vol-II, 5th Edition, Butterworth-Heinemann
2. McCabe, W.L., Smith, J.C., Harriott, P., (2005),"Unit operations of Chemical Engineering". 7th Edition McGraw Hill
3. Welty, J.R., Wicks, C.E., Wilson, R.E., Rorrer, G.L. (2007), ''Fundamentals of Momentum, Heat and Mass Transfer''. 5th Edition Wiley & Sons.
4. Perry, R.H., Green, D.W (2007) "Perry's Chemical Engineers' Handbook, 8th Edition", McGraw Hill
5. Richard Baker, (2004),"Membrane Technology and Applications", 2nd Edition Wiley
6. Seader, J. D., Henley, E. J. (2006), "Separation Process Principles", 2nd Edition Wiley
7. Wankat, Phillip C. (2011), "Separation Process Engineering: Includes Mass Transfer Analysis" Prentice Hall

III CHE 363 Fuels and Combustion

Course Outlines

- **Title:** Fuels and Combustion
- **Code Number:** CHE 363
- **Semester:** 6th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHE122, CHE231
- **Learning Outcomes:**

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

1. Identify various types of solid, liquid and gaseous fuels
2. Evaluate combustion mechanism, reactions and combustion equipment
3. Solve problems related to fuels and combustion

- **Contents**

Unit I: Introduction

1.1 Energy sources and resources
1.2 Classification of fossil and hydrocarbon fuels
1.3 Chemistry of hydrocarbons

Unit II: Solid Fuels

2.1 Classification of solid fuels
2.2 Coal preparation and Coal Cleaning
2.3 Coal gasification
2.4 Coal liquefaction

Unit III: Liquid Fuels

3.1 Classification of liquid fuels
3.2 Preliminary treatment
3.3 Significant tests, specification and uses
3.4 Synthetic liquid fuels
3.5 Internal Combustion Engines

Unit IV: Gaseous Fuels

4.1 Natural Gas
4.2 Gases produced by carbonization of solid fuels
4.3 Measurement of calorific value of gaseous fuels
4.4 Analysis of flue and fuel gases
4.5 Technical merits of gaseous fuel over other fuels
4.6 Gaseous Fuel Burners and their selection for different gaseous fuels

Unit V: Combustion of Fuels

5.1 Combustion theory and mechanism
5.2 Combustion reactions and efficiency
5.3 Combustion characteristics of various fuels
5.4 Flame dynamics and characteristics
5.5 Combustion equipment for solid, liquid and gaseous fuels
5.6 Hazards, emissions from fuel processing and utilization

- **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.

Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations:**

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

- **Textbooks and reference readings**

1. Glassman, I., Yetter, R.A., Glumac, N.G. (2015), "Combustion", 5th Edition Academic.
2. Speight, J.G. (2015), "Handbook of petroleum product analysis"; 2nd Edition Wiley & Sons
3. Lackner, M., Palotás, A., Winter, F., (2013), "Combustion: From Basics to Applications", Wiley & Sons
4. Keating, E.L. (2007), "Applied Combustion", 2nd Edition, Taylor & Francis
5. Brame, J.S.S. (2018), "Fuel: Solid, Liquid and Gaseous", Creative Media Partners
6. Perry, R.H., Green, D.W (2007), "Perry's Chemical Engineers' Handbook, 8th Edition", McGraw Hill

IV CHE364 Unit Processes

Course Outlines

- **Title:** Unit Processes
- **Code Number:** CHE364
- **Semester:** 6th

- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** CHEM116
- **Learning Outcomes:**

  Upon successful completion of the course the students should be able to

  1. Describe the fundamentals of unit processes.
  2. Elaborate the mechanisms of different unit processes.
  3. Develop reaction path for synthesis of chemical products and adducts.

- **Contents**

  Unit I: Nitration

  1.1 Introduction
  1.2 Kinetics and reaction mechanisms
  1.3 Industrial Applications

  Unit II: Amination by reduction

  2.1 Introduction
  2.2 Kinetics and reaction mechanisms
  2.3 Industrial Applications

  Unit III: Diazotization

  3.1 Introduction
  3.2 Kinetics and reaction mechanisms
  3.3 Industrial Applications

  Unit IV: Amination by Ammonolysis

  4.1 Introduction
  4.2 Kinetics and reaction mechanisms
  4.3 Industrial Applications

  Unit V: Sulphonation and Sulphation

  5.1 Introduction
  5.2 Kinetics and reaction mechanisms
  5.3 Industrial Applications

  Unit VI: Alkylations

  6.1 Introduction
  6.2 Kinetics and reaction mechanisms
  6.3 Industrial Applications

Unit VII: Esterification

7.1 Introduction
7.2 Kinetics and reaction mechanisms
7.3 Industrial Applications

Unit VIII: Industrial Electrochemical Processes

8.1 Introduction
8.2 Reaction mechanisms
8.3 Industrial Applications

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Groggins, P.H. (2001),"Unit Process in Organic synthesis", 5th Edition McGraw Hill
2. Othmer,K.(1999), "Encyclopedia of Chemical Technology", Inter – Science.
3. Austen, G.T. (1997), "Shreve's Chemical Process Industries", 6th Edition McGraw Hill
4. Kent, James A. (2003), "Riegels Handbook of Industrial Chemistry", 10th Edition Springer/Van Nostrard Reinhold

V CHE365A Polymer Engineering

Course Outline

- **Title:** Polymer Engineering
- **Code Number:** CHE365A
- **Semester:** 6th
- **Credit hours:** 2
- **Pre-requisites course requirements/skills:** CHEM116
- **Learning Outcomes:**

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

  1. Understand the characteristics and applications of various polymeric materials
  2. Describe the principles and methods of polymerization
  3. Identify the processing path of polymerization for particular properties.
- **Contents**

  Unit I : Introduction

  1.1 Polymerization
  1.2 Co-polymerization
  1.3 Principles of Polymers Formation
  1.4 Flow Properties of Polymers,
  1.5 Classification of Melt Flow Behavior

  Unit II : Structure and Properties of Polymer

  2.1 Analysis and Testing of Polymers
  2.2 Production and Properties of Commercially Important Polymers;

  Unit III : Polymer Processing

  3.1 Design of equipment and machinery used
  3.2 Recent advances in polymer technology.

- **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.

Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Fried, J.R. (2003) "Polymer Science and Technology", 2nd Edition, Prentice Hall.
2. Steed, J.W., Atwood, J.L. (2009), " Supramolecular Chemistry", 2nd Edition Wiley & Sons
3. Ossworld, T.A., Menges, G., Hanser (2003), "Material Science of Polymer for Engineering" 3rd Edition, McGraw Hill.
4. Ferdin R, Cohen, C., Christopher, K.O., Lynden A.A., (2003), "Principles of Polymer Systems, 5th Edition, Tayler & Francis.
5. Kumar A., Rakesh K.G., (2003), "Fundamentals of Polymers", McGraw Hill.
6. Ahluwalia V.K., A. Mishra, (2008), "Polymer Science",Taylor & Francis.
7. Van Herk, A.M. (2013), "Chemistry and Technology Emulsion Polymerization", 2nd Edition, Wiley & Sons.

V CHE365B Natural Gas Engineering – II

Course Outline

- **Title:** Natural Gas Engineering-II
- **Code Number:** CHE365B
- **Semester:** 6th
- **Credit hours:** 2

- **Pre-requisites course requirements/skills:** Basic understanding of physical chemistry and mathematics.
- **Learning Outcomes:**

  Upon successful completion of the course, the students will be able to
  1. Describe the specifications, terminology and operation for natural gas transmission and distribution systems.
  2. Perform calculations to estimate gas flow and sizing of mains using practical flow equations and distribution pressures.
  3. Analyze environmental, safety and economic aspects of natural gas transmission and distribution system.
- **Contents**

  Unit I: Natural Gas Transmission

  1.1 Gas Compression Stations
  - 1.1.1 Types of compressors
  - 1.1.2 Thermodynamics of gas Compression

  1.2 Raw and Sales gas transmission

  1.3 Pipeline network
  - 1.3.1 Outline of major steps in a transmission
  - 1.3.2 Pipeline project
  - 1.3.3 Pipeline capacity/deliverability and efficiency
  - 1.3.4 Piping codes, standards and classification of steel pipe construction

  1.4 Engineering design of high-pressure natural gas transmission pipelines

  1.5 Pipeline routing using topographical maps

  1.6 Obstacles encountered in pipeline network construction.
  - 1.6.1 Pipeline protection, monitoring and maintenance.
  - 1.6.2 Operational problems of high-pressure pipelines.

  Unit II: Natural gas Distribution

  2.1 Types of distribution systems

  2.2 Flow calculations and sizing of mains using practical flow equations

  2.3 Estimation of design loads
  - 2.3.1 Modification of existing systems

  2.4 Design of new distribution systems

  2.5 Gas metering

  2.6 Pressure regulators
  - 2.6.1 Domestic
  - 2.6.2 Commercial/Industrial.

  Unit III: Natural Gas Utilization

  3.1 Gas burners

3.1.1 Types, design and operation
3.1.2 Rating and performance
3.2 Combustion and stoichiometric calculations
3.3 Industrial gas-fired furnaces
3.4 Useful chemical from natural gas conversion
3.5 Natural gas economics, safety and environmental aspects
3.6 Utilization of CNG, LPG and LNG.

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Saeid M., William A. P., John Y.M., (2019), "Handbook of Natural Gas Transmission and Processing: Principles and Practices", 4th Edition, Gulf.
2. Kidnay A.J., Parrish, W.R., (2006), "Fundamentals of Natural Gas Processing" CRC.
3. Katz D.L., Lee R.L., (1990), "Natural Gas Engineering", McGraw Hill.
4. Brian S., (2010), "Piping Systems Manual", McGraw Hill.

V CHE365C Renewable Energy Engineering

Course Outlines

- **Title:** Renewable Energy Engineering
- **Code Number:** CHE365C
- **Semester:** 6th
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** Basic understanding of energy resources and their applications.
- **Learning Outcomes:**

  Upon successful completion of the course, the students will be able to
  1. Understand the fundamental concepts of energy to power and renewable energy technologies by describing the fundamental principles of operations.
  2. Evaluate and compare renewable energy sources.
  3. Apply the basic knowledge to solve renewable energy related engineering problems.
- **Contents**

  Unit I: Energy to Power

  1.1 Fundamentals associated with energy, power and conventions
  1.2 Energy consumption by source
  1.3 Steam- Carnot theorem, phase change of steam
  1.4 Thermal electrical generation and steam
  1.5 Turbines, blade design, turbine systems
  1.6 Energy conversion, steam turbine plant, natural gas combustion open cycle plant, Combined cycle plants
  1.7 Components of power plant, sub-systems of a typical plant, boiler and furnace

  Unit II: Energy from Biomass

  2.1 Renewable and non-renewable technologies
  2.2 Drivers for using biomass as energy
  2.3 Types of biomass, first-second and third generation biomass
  2.4 Biomass analysis- hemicellulose, cellulose and lignin content determination
  2.5 Hemicellulose, cellulose and lignin decomposition pathways
  2.6 Biomass devolatilisation kinetics
  2.7 Biomass energy products, problems associated with biomass materials conversion routes (biochemical, thermochemical)

Unit III: Solar Energy Systems

3.1 Applied solar energy, solar irradiance, solar cell structure
3.2 Solar cell system- working principle
3.3 Solar energy uses,
3.4 Efficiency and disadvantages comparison
3.5 Future of solar energy in Pakistan
3.6 Solar plant sizing exercises, solar power system designing exercise

Unit IV: Geothermal Energy

4.1 Geothermal resource, geothermal-water cycle, potential geothermal areas
4.2 Direct use of geothermal heat, geothermal systems, indirect production of power, geothermal heat pumps, heat mining, hybrid heat pumps
4.3 Geothermal electrical energy plant layouts, geothermal heat transfer fluid
4.4 Air conditioning, air conditioning heat pump
4.5 Advantages and disadvantages of geothermal energy, future of geothermal energy

Unit V: Tidal Energy

5.1 Hydropower-water cycle, periodic tides, tidal energy conventions
5.2 Tidal energy configurations
5.3 Advantages and disadvantages of geothermal energy, future of tidal energy

Unit VI: Wind Energy

6.1 Wind turbine power, wind power density
6.2 Main component of a wind turbine
6.3 Limitations of wind power
6.4 Future of wind power

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Everett B. (2012), "Energy Systems and Sustainability: Power for sustainable future", Oxford University.
2. Gicquel R., (2011), "Energy Systems: A new approach to engineering thermodynamics", Taylor & Francis
3. Bhatia S.C., (2014), "Advanced Renewable Energy Systems Part-1", Woodhead.
4. Rosa A.V., (2013), "Fundamentals of Renewable Energy Processes", Elsevier.
5. Raja, A.K., Srivastava, A.P. (2006), "Power Plant Engineering", New Age.
6. Gevorkian P., (2006), "Sustainable Energy Systems Engineering", McGraw Hill.

VI CHE366 Separation Processes-II Lab

Practicals pertaining to the course outlined in CHE 362

VII CHE367 Fuels and Combustion Lab

Practicals pertaining to the course outlined in CHE363

VIII CHE368 Unit Processes Lab

Practicals pertaining to the course outlined in CHE364

IX CHE 400 Internship

4-6 weeks industrial training in Chemical Process Industry. A formal report to be submitted.

7TH SEMESTER

I MGT471 Production and Operations Management

Course Outlines

- **Title:** Production and Operations Management
- **Code Number:** MGT471
- **Semester:** 7th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** Basic understanding of management principles involved in chemical process industries.

- **Learning Outcomes:**

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

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

- **Contents**

  Unit I: Nature and Scope of Operation Management

  1.1 Introduction to production management functions
  1.2 Classification of production systems
  1.3 Production Operation Strategies
  - 1.3.1 Vision and mission
  - 1.3.2 Goals and objectives
  - 1.3.3 Tactics to control production and operations in an enterprise

  Unit II: Decision Making

  2.1 Decision process
  2.2 Characteristics of operation decision
  2.3 General approach to decision making
  2.4 Decision Models
  2.5 Resource Allocation
  2.6 Analysis of Production forecasting and scheduling
  2.7 Forecasting Environments and their assessment

Unit III: Design of Work System in an enterprise

3.1 Basic types of facility layout
3.2 Concept of line balancing and waiting line
3.3 Measuring system performance
3.4 Reliability and Liability
3.5 Product Life Cycle
3.6 Process selection and capacity planning
3.7 Breakeven Analysis

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Ried, R.D. , Sanders, N.R. (2015), "Operations Management: An integrated approach" 6th Edition, Wiley & Sons.
2. Stevenson, W.J. (1999), "Production Operations Management" 6th Edition, McGraw Hill.
3. Muhlemann (2007), "Production Operations Management" 6th Edition, Pearson.
4. Chelsom,J.V., Payne A.C., Reavill R.P.(2005), "Management for Engineers, Scientists and Technologists" 2nd Edition, Wiley.

II CHE472 Chemical Plant Design

Course Outlines

- **Title:** Chemical Plant Design
- **Code Number:** CHE472
- **Semester:** 7th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHE122, CHE231
- **Learning Outcomes:**

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

  1. Define a design problem and related terminology
  2. Search design information and data
  3. Select suitable process equipment for engineering applications
  4. Design process equipment like heat transfer equipment and separation columns.
  5. Apply principles of mechanical design, economics and safety in the design of process equipment
- **Contents:**

  Unit I: Introduction to Design

  1.1 Nature of design
  1.2 Organization of Chemical Engineering project
  1.3 Health and Safety in design, Fire and Explosion Hazards
  1.4 Introduction to Computer Aided Design.
  1.5 Design Information and Data
  - 1.5.1 Source of information on manufacturing processes
  - 1.5.2 General sources of physical properties
  - 1.5.3 Accuracy required of engineering data
  - 1.5.4 Prediction of physical properties, phase equilibrium data

  Unit II: Design of Separation Columns

  2.1 Approximate column sizing
  2.2 Plate contactors
  2.3 Plate hydraulic design Packed columns
  2.4 Column auxiliaries

  Unit III: Design of Heat Transfer Equipment

  3.1 Basic design procedure and theory of shell and tube exchangers
  3.2 Condensers

3.3 Reboilers and Vaporizers
3.4 Plate heat exchangers
3.5 Direct-contact heat exchangers
3.6 Finned tubes exchanger
3.7 Double-pipe heat exchangers
3.8 Air-cooled exchangers
3.9 Fired heaters.

Unit IV: Design of Miscellaneous Equipment

4.1 Liquid-Solid separators
4.2 Separation of dissolved solids
4.3 Liquid-Liquid separation of dissolved liquids
4.4 Gas-Solids separations
4.5 Gas-liquid separators
4.6 Transport and storage of materials.

Unit V: Mechanical Design of Process Equipment

5.1 Brief introduction to mechanical design of process equipment: Classification of pressure vessels
5.2 Pressure vessels codes and standards
5.3 Fundamental principles and equations
5.4 General Design considerations of Pressure vessels
5.5 Design of thin-walled vessels under internal pressure
5.6 Compensation for opening and branches
5.7 Design of vessels subject to external pressure
5.8 Design of vessels subject to combined loading Vessel supports: Bolted flanged joints
5.9 Fatigue assessment of vessels
5.10 Pressure tests
5.11 Liquid storage tanks.

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Coulson, J. M., Sinnott, R.K., Richardson J.F. (2005) "Chemical Engineering: Chemical Engineering Design", Vol-VI, 4th Edition, Butterworth-Heinemann.
2. Peters, M.S., Timmerhaus, K.D., West, R.E. (2003) "Plant Design and Economics for Chemical Engineers" 4th Edition, McGraw Hill.
3. Ludwig, E.E.(2001) "Applied Process Design for Chemical and Petrochemical Plants" 3rd Edition, Elsevier.
4. Couper, James R. W., Penney, R., Fair, J.R., Walas, S.M. (2005) "Chemical Process Equipment: Selection and Design" 2nd Edition, Gulf.
5. Brown T. (2016), "Engineering Economics and Economic Design for Process Engineers" CRC.

III CHE473 Instrumentation and Process Control

Course Outlines

- **Title:** Instrumentation and Process Control
- **Code Number:** CHE 473
- **Semester:** 7th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHE122, CHE231
- **Learning Outcomes:**

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

1. Describe basic principles and working of measuring instruments used in process industries.
2. Explain the dynamic behaviour of processes in terms of transfer functions.
3. Analyse suitable controller and control scheme for a given industrial process.

- **Contents**

Unit I: Instrumentation for Process Control

1.1 Static and dynamic characteristics of instruments.
1.2 Types of measurements and instrument errors.
1.3 Working principle and application of process instruments for process variables
1.4 Control valve types and characteristics.

Unit II: Dynamics of Process Control

2.1 Modelling and analysis of process control
2.2 Transfer functions and their determination using input-output models and Laplace transformation.
2.3 Dynamic response of first and second order systems to various input functions.
2.4 Linearization of higher order systems.
2.5 Overall transfer function and closed loop response.

Unit III: Application of Process Control

3.1 Introduction and significance of Process Control.
3.2 Concept of feedback control.
3.3 Effect of proportional, integral, derivative, and composite actions on response of controlled processes.
3.4 Controller tuning.
3.5 Introduction to frequency response analysis; Routh-Hurwitz method, Bode and Nyquist plots.
3.6 Feed Forward Control
3.7 Multi-loop control: Cascade Control, Ratio Control, Selective Control, Split Range Control.
3.8 Control loops for common industrial process equipment

- **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.

Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Coughanowr, D.R., LeBlanc, S.E. (2009), "Process Systems Analysis and Control" 3rd Edition. McGraw Hill.
2. Smith, C.A., Corripio, A.B. (2003), "Principles and Practice of Automatic Process Control" 3rd Edition, Wiley.
3. Seborg, D.E., Mellichamp, D.A., Edgar,T.F., Doyle,F.J.(2010) "Process Dynamics and Control" 3rd Edition, Wiley & Sons.
4. Smith, C.L., (2009), "Practical Process Control: Tuning and Troubleshooting", Wiley & Sons.
5. Liptack, B. (2012) "Instrument and Automation Engineers' Handbook: Process Measurement and Analysis," Vol-I, CRC.
6. King, M. (2010) "Process Control: A Practical Approach", Wiley & Sons.
7. Marlin, T.E. (2000), "Process Control: Designing Processes and Control system for Dynamic Performance" 2nd Edition, McGraw Hill.

IV CHE 474 Design Project Part I

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 flow sheet, material balances, energy balances, safety aspects, equipment sizing, development of flow sheet, P and I diagram, materials 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.

V CHE 475A Petrochemical Engineering

Course Outlines

- **Title:** Petrochemical Engineering
- **Code Number:** CHE 475A
- **Semester:** 7th
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** CHE111, CHE121
- **Learning Outcomes:**

  Upon successful completion of the course, the students will be able to:
  1. Identify various petrochemical resources and suitable raw materials.
  2. Understand different petrochemical manufacturing processes
  3. Acquire knowledge for treatment of various petrochemical products

- **Contents**

  Unit I: Hydrocarbons from petroleum fuels

  1.1 Hydrocarbon sources and raw materials; their characterization, availability and pricing.
  1.2 Synthesis gases and their derivatives
  1.3 Sources of olefinic and aromatic hydrocarbons

  Unit II: Chemical treatment of petroleum derivatives

  2.1 Production of chemicals form Ethylene, Propylene
  2.2 Treatment of olefinic C4 and C5 cuts for production of chemicals
  2.3 Treatment of Aromatic gasolines
  2.4 Chemicals and polymers from Benzene, Toluene and xylene.
  2.5 Monomers for the synthesis of elastomers

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference reading:**

1. Chauvel, A., Lefebvre, G. (1989), "Petrochemical Processes, Synthesis gas derivatives and major hydrocarbons" Technip Editions.
2. Robert A. Meyers (2005), "Handbook of Petrochemical Production Processes" McGraw Hill.
3. Wittcoff A.H., Bryan G. R., Plotkin J.S. (2000), "Industrial organic chemicals" 2nd Edition. Wiley.

V CHE 475B Petroleum Refinery Engineering – I

Course Outlines

- **Title:** Petroleum Refinery Engineering-I
- **Code Number:** CHE 475B
- **Semester:** 7th
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** CHE363
- **Learning Outcomes**

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

1. Understand the specifications for crude oil and its refining operations and purification and sweetening of various refinery products.
2. Perform calculations to determine different refining parameters e.g. GAP, Overlap, boiling point curves, viscosity, mol. weight etc.
3. Use different distillation curves for determining the cut points and yield of various fractions and perform material and energy balance.

- **Contents**

  Unit I: Refinery Distillation

  1.1 Theory of fractionation.
  1.2 Distillation schemes, atmospheric distillation (AD), vacuum distillation(VD).
  1.3 Basic arrangements of fractionating towers.
  1.4 Sidestream steam strippers.
  1.5 Kinds of reflux for distillation units

  Unit II: Material and Energy Balance around ADU and VDU

  2.1 Concepts and applications of TBP cut point
  2.2 Determination of number of plates in various sections
  2.3 Calculation of plate temperatures and vapour-liquid traffic in the column.
  2.4 Stabilization of natural-gasoline. Reboilers. Operation, control and maintenance of distillation units.

  Unit III: Chemical Treatments

  3.1 Sulphuric acid treatment.
  3.2 Caustic treatment.
  3.3 Sweetening treatments
  3.4 Desulphurization: solvent extraction processes; catalytic desulphurization.

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Edmister, W. C., Lee, B.K.(1988), "Applied Hydrocarbon Thermodynamics" 2nd Edition Gulf.
2. Gary, J.H., Handwerk, G. E., Kaiser, M. J. (2007) "Petroleum Refining: Technology and economics". 5th Edition CRC.
3. Speight, J. G. (2007), "The chemistry and technology of petroleum" 4th Edition Taylor & Francis.
4. Watkins, R. N. (1979),"Petroleum refinery distillation". 2nd Edition Gulf.
5. Abdel, H. K., Bakr, B.A., Al-Sahlawi, M. A.(1992), "Petroleum Economics and Engineering" 2nd Edition Marcel Dekker.
6. Goodger, E. M. (1975), "Hydrocarbon fuels: production, properties and performance of liquids and Gases" Macmillan.
7. Nelson, W. L. (1958), "Petroleum refinery engineering" 4th Edition McGraw Hill.
8. Wauquier J.P., (2000) "Petroleum Refining series: Separation Process" Technip Editions.

V CHE475C Industrial Energy Systems

Course Outlines

- **Title:** Industrial Energy Systems
- **Code Number:** CHE475C
- **Semester:** 7th
- **Credit hours:** 2
- **Pre-requisites course requirements/skills:** CHE232
- **Learning Outcomes:**

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

1. Understand the basic principles and importance of industrial energy systems in industrial processes.
2. Apply the knowledge of process heat integration and energy conversion technologies for efficient use of energy.

- **Contents**

Unit I: Introduction

1.1 Industrial energy system concepts
1.2 Heat balances and heat distribution systems

Unit II: Energy conversion technologies in industrial energy systems

2.1 Overview of technologies and engineering thermodynamics for steam turbine combined heat and power (CHP) and gas turbine CHP.
2.2 Energy conversion performance of such systems for given energy conversion process parameters and given process heat load.
2.3 Methodology for identifying cost-optimal mix of technologies for satisfying a process heat demand, accounting for heat load variation over the course of the year.

Unit III: Process Heat Integration

3.1 Introduction to Process Heat Integration for increased energy efficiency
3.2 Pinch Technology for maximum energy recovery

Unit IV: Consequences of energy efficiency measures in industry

4.1 Greenhouse gas emissions from industrial energy systems and emission reduction measures.
4.2 Optimization of industrial energy systems considering future costs associated with greenhouse gas emissions.

- **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.

Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Kemp I.C. (2011) "Pinch Analysis and Process Integration: A User Guide on Process Integration for the Efficient Use of Energy" Elsevier.
2. Smith R. (2016), "Chemical Process Design and Integration" Wiley & Sons.
3. Khartchenko N.V., Kharchenko V.M. (2013) "Advanced Energy Systems" CRC.
4. Putman R.E. (2004), "Industrial Energy Systems: Analysis, Optimization, and Control", ASME.
5. Kveith, F., Goswami D.Y. (2007), "Energy Management and Conservation Handbook", CRC.

VI HUM476 Industrial Psychology, Sociology and Tolerance

Course Outlines

- **Title:** Industrial Psychology, Sociology and Tolerance
- **Code Number:** HUM476
- **Semester:** 7th
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** Basic understanding of social behavior and ethics.
- **Learning Outcomes:**

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

1. Understand the role of different groups working in workplace or organization.
2. Comprehend the structure of society, personality of the person and socialization procedure.

3. Apply the knowledge of sociology, psychology and tolerance in changing world of industrial organization.

- **Contents**

Unit I: Organizational and Industrial Psychology

1.1 Nature, Scope and application with special reference to Pakistan
1.2 Methods of Psychology, Intelligence, Personality assessment
1.3 Understanding maladjusted behavior
1.4 Stress management and anger management
1.5 Conflict and consent in work: the labour process debate; work place control and resistance; Industrial conflict and industrial relations
1.6 Organizational culture; Organizational culture and strategic management; exploring organizational culture; evaluating concept of culture.

Unit II: Applied Sociology

2.1 The Nature of sociology: the study of social life
2.2 Sociology as a science
2.3 Brief historical development of sociology; Society and community
2.4 Social interaction processes
2.5 Culture and related concepts
2.6 Socialization and personality: Role and status
2.7 Social Stratification
2.8 Impact of globalization on society and culture
2.9 Religious harmony and tolerance.

Unit III: Corruption and Anti-Corruption

3.1 What is Corruption and Anti-Corruption?
3.2 Corruption and good governance
3.3 Corruption and human rights
3.4 Citizen participation in anti-corruption

- **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.

Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Fincham, R., Rhodes, Peter S. (2005), "Principles of organizational behaviour", Oxford University.
2. Noe, R., Hollenbeck, J. Gerhart, B., Wright, P. (2006), "Human Resources Managements", 5th Edition, McGraw Hill.
3. Newstrom John W. (2007), "Organizational Behaviour", 12th Edition, McGraw Hill
4. Donohue, W., Ferguson, K. (Eds) (2003), "Handbook of Professional Ethics for Psychologists; Issues, Questions and controversies", Sage.
5. Giddens, Anthony, (2004), "Sociology" 4th Edition, Cambridge Polity.
6. Richard, T. Schaefer, (2003), "Sociology" 5th Edition, McGraw Hill
7. Kendall, Diana, (2004), "Sociology in our Times", 4th Edition, Wadsworth.

VII CHE 477 Instrumentation and Process Control Lab

Practicals pertaining to the course outlined in CHE473

VIII CHE 478 Process Design and Simulation Lab

Course Outlines

- **Title:** Process Design and Simulation Lab
- **Code:** CHE478
- **Semester**:7th

- **Credit hours:** 1
- **Pre-requisites course requirements/ skills:** CHE247
- **Learning Outcomes**

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

  1. Understand simulation of chemical operations and processes
  2. Solve chemical engineering design problems using the simulation software.
  3. Prepare formal lab report.

- **Contents**

  Unit-I: Introduction

  1.1 Significance of Process Simulation in Chemical Engineering
  1.2 Process simulation techniques
  1.3 Structure of process simulator
  1.4 Working with simulation software
  1.5 Selection of components and developing process flowsheet

  Unit-II: Simulation of individual unit operations and processes

  3.1 Simulation of heat exchanger
  3.2 Simulation of separation equipment
  3.3 Simulation of reactor system
  3.4 Simulation of systems with Recycle stream

  Unit-III: Application of software in process design and analysis

  3.1 Process Design using available software
  3.2 Dynamic Analysis and Process Control
  3.3 Profitability Analysis
  3.4 Sensitivity Analysis

- **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 and activities using computer, multi-media and writing board instructional aids.

  Lab Lectures: 3 contact hours per week
  Software: MATLAB, Aspen Hysys

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the final term examination.

- **Assessment and Examinations**

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written/Practical examination at the mid-point of the semester.
2.	Formative Assessment	25%	It includes: lab participation, attendance, assignments and performance on computer.
3.	Final Assessment	40%	Written/Practical examination at the end of semester.

- **Textbooks and reference readings**

1. Finlayson, B. A. (2012), "Introduction to Chemical Engineering Computing" 2nd Edition, Wiley & Sons.
2. Loney, N.W.(2006) "Applied Mathematical Methods for Chemical Engineers" 2nd Edition, CRC Press.
3. Chaves, I.D., López, J.R., García, J.L., Robayo, A.L., Rodríguez, G.N. (2015), "Process Analysis and Simulation in Chemical Engineering", Springer.
4. Kharab, A. and Guenther, R.B. (2001), "An Introduction to Numerical Methods" 3rd Edition, CRC Press.
5. Ghasem, N. (2011) "Computer Methods in Chemical Engineering", CRC Press.

IX HUM700 Quranic Translation

The students will learn Holy Quran with translation in this module. The module is added as per decision of Academic Council.

8TH SEMESTER

I MGT481 Industrial Management and Process Economics

Course Outlines

- **Title:** Industrial Management and Process Economics
- **Code Number:** MGT481
- **Semester:** 8th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** Basic understanding of management principles involved in chemical process industries.
- **Learning Outcomes:**

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

  1. Describe the planning and organisational functions.
  2. Understand the plant operational responsibilities.
  3. Analyse the cost estimates and industrial process economics.

- **Contents**

  Unit I: Functions of Management

  1.1 Leadership skills and responsibilities
  1.2 Planning and organizing functions
  1.3 Team development
  1.4 Industrial Audits

  Unit II: Plant location and Process improvement

  2.1 Factors affecting plant location
  2.2 Analysis of supply chain for product distribution to customers
  2.3 Economic evaluation of chemical plant
  2.4 Production capacity improvements
  2.5 Turnaround and overhaul planning
  2.6 Maintenance scheduling and repairs during operations

  Unit III: Process Economics

  3.1 Characteristics of chemical industry.
  3.2 Types of cost and cost estimation
  3.3 Capital investments.
  3.4 Legal responsibility of organizations

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Freeman, Bell G., Blackwill J. (1996) "Management in Engineering Principles and Practice" 2nd Edition, Prentice Hall.
2. Buffa, Elwood S. (1981), "Elements of Production Operations Management", Wiley & Sons.
3. Saiyadian M. S. (2000) "Human Resources Management" 2nd Edition, McGraw Hill.
4. Peters, Max S., Klaus D., West E. (2003). "Plant Design and Economics for Chemical Engineers" 5th Edition, McGraw Hill.
5. Leland B., Anthony T. (2005), "Engineering Economy", 6th Edition, McGraw Hill.
6. Khanna O. P. (2006), "Industrial Engineering and Management ", 2nd Edition, Dhanpat Rai Sons
7. Ted G. E. (2003), "Engineering Economy" 2nd Edition, Oxford University.

II CHE482 Process Analysis and Optimization

Course Outlines

- **Title:** Process Analysis and Optimization
- **Code Number:** CHE482
- **Semester:** 8th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHE122, CHE231
- **Learning Outcomes:**

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

  1. Explain a process design optimization problem
  2. Select suitable process models for process optimization
  3. Set up complex process design optimization problems
  4. Apply knowledge of the subject to optimize the chemical processes

- **Contents**

  Unit I: Use of models in process engineering

  1.1 Model as a working description of a system.
  1.2 Types and function of model: mechanistic, empirical, stochastic, procedural and qualitative.
  1.3 Reasoning for using models.
  1.4 Strategy for model building: Relationship between engineering and mathematical approximations. Example of dynamic delay of air heater.

  Unit II: Conceptual models

  2.1 Formulation of functional - mechanistic models based on conservation equations. Coordinate free methods based on vector/ matrix notation.
  2.2 Models for complex and irregular geometry.
  2.3 Case study examples for heat exchanger and tubular reactor definition of system parameters consistent with the model.
  2.4 Averaging and model reduction techniques.
  2.5 Numerical procedures based on weighted residuals.

  Unit III: Adaptive Models

  3.5 Empirical models based on non-linear regressive adaptive refinement of models
  3.6 State variables models and matrix differential equations.
  3.7 Filtering and continuous up-dating of models.

3.8 State estimation and adaptive control.

3.9 Population balance models: Description of process in terms of distribution functions based on principal attributes.

3.10 Process vessel characteristics in terms or residence time distribution functions.

3.11 Standard models based on plug flow, CSTR and dead space.

3.12 Mixing and age distribution.

3.13 Application to reaction systems and liquid-liquid extraction.

3.14 Quantitative models: Diagnostics procedures. Signal flow graphs. Reasoning with qualitative models.

Unit IV: Models for Process Simulation

4.1 Analysis of systems behavior for process optimization, flexibility and safety.

4.2 Stability and multiple states.

4.3 Optimization methods; Analytical/numerical techniques for single variable and multi variable (constraint and unconstrained) functions; linear programming; PERT and CPM project and its organization.

- **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.

Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Edgar T. F., Himmelblau D. M. (2003), "Optimization of Chemical Processes", McGraw Hill.
2. Babu B. V. (2004), "Process Plant Simulation", Oxford University.
3. Bruce E. N. (2002), "Chemical Reactor Design, Optimization and Scale up" McGraw Hill.
4. Silla H. (2003), "Chemical Process Engineering, Design and Economic", Marcel Dekker.
5. Dimian A. C., Bildea C. S. (2008), Chemical Process Design: Computer-Aided Case Studies, Wiley-VCH.
6. Lewin D. R. (2010), "Unit Process Simulator in Chemical Engineering: A Multimedia Guide for the Core Curriculum". (Version 2.3), 3rd Edition, Wiley.
7. Wells G. L., Rose L. M. (1986) "The art of Chemical Process Design (Computer-Aided Chemical Engineering, 2) "Elsevier.
8. Datta A., (2008), "Process Engineering and Design using visual Basic", CRC.
9. Robin S. (2004), "Chemical Process Design and Integration", Wiley.
10. Benny R., Ian S. (2003), "Fundamentals of Computer-Aided Engineering", Wiley.

III CHE483 Design Project Part II

Students will continue work on the Design Project Part I. They will work on equipment sizing, development of flow sheet, P and I diagram, materials selection and cost estimation. The progress will be monitored through interim presentations and report. A final report will be due at the end of term.

IV CHE484A Biochemical Engineering

Course Outlines

- **Title:** Biochemical Engineering
- **Code Number:** CHE484A
- **Semester:** 8th
- **Credit Hours:** 2
- **Pre-requisites course requirements/ skills:** CHE356
- **Learning Outcomes**

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

  1. Describe the basic concepts of biochemical engineering, biochemistry and microbiology.
  2. Understand the concepts related to biocatalysts and biochemical reactors.
  3. Solve problems related to kinetics of fermentation reactions.

- **Contents**

  Unit I: Microbiology and enzyme catalysis

  1.1 Basic of Microbiology
  1.2 Enzyme Classification
  1.3 Enzyme reaction kinetics and energy patterns in biological system
  1.4 Enzyme Inhibition and non-ideal Enzyme Kinetics
  1.5 Isolation of enzymes and immobilized enzyme technology
  1.6 Applications of Enzyme Catalysis

  Unit II: Design of biochemical reactors and applications of biochemical engineering

  2.1 Transport phenomenon in microbial system
  2.2 Design and analysis of biochemical reactors and fermenters
  2.3 Anaerobic and aerobic metabolism photosynthesis and biosynthesis
  2.4 Biochemical and microbiological engineering application to commercial production

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and suggested readings**

1. Das, D., Das, D. (Eds.). (2019), "Biochemical engineering: An introductory textbook", CRC.
2. Katoh, S., Horiuchi, J. I., Yoshida, F., (2015), "Biochemical engineering: A textbook for engineers, chemists and biologists", 2nd Edition, Wiley-VCH.
3. Haider, S. I., Ashtok, A., (2009), "Biotechnology: A comprehensive Training Guide for the Biotechnology Industry", CRC.
4. Michael, L. S. , (2001), "Bioprocess Engineering: Basic Concepts", 2nd Edition, Prentice Hall.
5. Clark, D. S., Blanch, H. W., (1997), "Biochemical engineering", CRC.

IV CHE 484B Petroleum Refinery Engineering – II

Course Outlines

- **Title:** Petroleum Refinery Engineering-II
- **Code Number:** CHE484B
- **Semester:** 8th
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** CHE363
- **Learning Outcomes:**

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

  1. Understand fundamentals of petroleum refining, crude oil processing, and purposes of re-refining processes and properties of main oil products.
  2. Explain the various conversion processes with the help of process flow diagrams and chemical reactions involved.
  3. Apply linear programming techniques to solve refinery blending and production problems.

- **Contents**

  Unit I: Conversion Processes:

  1.1 Thermal cracking and decomposition processes
  1.2 Mechanism of cracking and reactions
  1.3 Coking and Visbreaking
  1.4 Catalytic cracking, fluidized-bed catalytic cracking unit (FCCU)
  1.5 Catalytic reforming and isomerization
  1.6 Hydro treating, hydrocracking and hydro processing

1.7 Naphtha hydrotreater, Naphtha cracker.
1.8 Alkylation and polymerization processes.
1.9 Various established commercial processes.

Unit II: Lubricating Oil Processing

2.1 Lube de-asphalting processes
2.2 Furfural extraction, phenol extraction, N-methyl-pyrrolidone (NMP) extraction.
2.3 Lube de-waxing processes
2.4 Hydro-finishing, Wax finishing, Production of asphalts and waxes
2.5 New trends in lube oil de-asphalting, solvent extraction, and de-waxing.

Unit III: Miscellaneous Topics

3.1 Auxiliary refinery processes and operations
3.2 Refinery corrosion and metals
3.3 Specialty products
3.4 Storage tanks Safety and environmental concerns
3.5 Refinery economics, Blending plants, product design and marketing
3.6 Use of linear programming techniques to solve refinery blending and production problems.
3.7 Overview of national petroleum act
3.8 Downstream petrochemicals production in an integrated refinery complex
3.9 Use of Aspen Hysys to simulate various refinery unit operations and unit processes.

- **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.

Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Fahim M. A., Al-Sahhaf, T. A., Elkilani A. (2010). "Fundamentals of petroleum refining", Elsevier.
2. Gary J. H., Handwerk G. E., Kaiser M. J. (2007). "Petroleum Refining: Technology and economics", 5th Edition, Boca Raton: CRC.
3. Matar S., Hatch, L. F. (2001). "Chemistry of petrochemical processes". Elsevier.
4. Speight J. G. (2007), "The chemistry and technology of petroleum". 4th Edition, Taylor & Francis.
5. Watkins, R. N. (1979). "Petroleum refinery distillation", 2nd Edition, Gulf.
6. Abdel-Aal H. K., Bakr B. A. Al-Sahlawi M. A. (1992). "Petroleum Economics and Engineering", 2nd Edition, Marcel Dekker.
7. Goodger E. M. (1975), "Hydrocarbon fuels: production, properties and performance of liquids and Gases",Macmillan.
8. Nelson, W. L. (1958), "Petroleum refinery engineering", 4th Edition, McGraw Hill.

IV CHE484C Food Engineering

Course Outline

- **Title:** Food Engineering
- **Code:** CHE484C
- **Semester:** 8th
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** CHEM116

- **Learning Outcomes**

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

  1. Understand fundamentals of food processing and related standards.
  2. Explain the various processing techniques for different food sectors.
  3. Develop the processing path for a particular food product with desired qualities.

- **Contents**

  Unit I: Techniques for food preservation, packaging and Marketing

  1.1 Equipment used for food processing
  1.2 Processing of various cereals, fruits, vegetables, fat and oil.
  1.3 Raw material: Physical and chemical properties.
  1.4 Quality and safety requirements.

  Unit II: Effect of physiological changes

  2.1 Quality of finished product
  2.2 Introduction to GMP, HACCP and Personal Protective Equipment (PPE)
  2.3 Roll of temperature and humidity on shelf life of finished products.

  Unit III: Chemical and physical evaluation of raw material

  3.1 Finished products of common food industries
  3.2 Sensory evaluation.
  3.3 Safety and Hygiene

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Text books and reference reading:**

1. Fellow, P.J.,(2005), "Food Processing Technology: Principles and Practices" 2nd Edition, Taylor & Francis.
2. Leliveld, H.L.M., Mostral, M.A., Holah, J.,(2005), "Handbook of hygiene control in food industry" Woodhead.
3. Awan.J.A., (2006), "Food Processing and Preservation" Unitech.

V CHE485 Transport Phenomena

Course Outlines

- **Title:** Transport Phenomenon
- **Code Number:** CHE485
- **Semester:** 8th
- **Credit hours:** 3
- **Pre-requisites course requirements/ skills:** CHE232, CHE353
- **Learning Outcomes:**

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

1. Acquire skills for modelling of velocity, temperature and concentration distribution for various industrial processes.
2. Solve the problems requiring velocity, temperature and concentration distributions involved in a wide range of industrial operations.
3. Evaluate the processes defined for mass, energy and momentum transport.

- **Contents**

Unit I: Viscosity and the Mechanism of Momentum Transport

1.1 Newton's law of viscosity

1.2 Various interpretations of the Newton's law of viscosity
1.3 Vector notation of Newton's law of viscosity
1.4 Pressure and Temperature dependence of viscosity
1.5 Molecular theory of viscosity of gases at low density
1.6 Molecular theory of viscosity of liquids
1.7 Non Newtonian fluids and their mathematical models

Unit II: Shell Momentum Balance and Velocity Distributions

2.1 Concept of Shell Momentum Balance
2.2 Concept of boundary conditions
2.3 Velocity distribution in a flow of falling film
2.4 Flow through an annulus
2.5 Flow of two adjacent immiscible fluids

Unit III: Thermal Conductivity and the Mechanism of Energy Transport

3.1 Fourier's law of heat conduction
3.2 Temperature and pressure dependence of heat conductivity
3.3 Theory of thermal conductivity of gases at low density
3.4 Theory of thermal conductivity of liquids
3.5 Theory of thermal conductivity of solids
3.6 Thermal conductivity of composite solids

Unit IV: Shell Energy Balance and Temperature Distributions in Solids

4.1 Concept of shell energy balance
4.2 Concept of boundary conditions
4.3 Heat conduction with an electrical heat source
4.4 Heat conduction with a nuclear heat source
4.5 Heat conduction with a viscous heat source
4.6 Heat conduction with a chemical heat source

Unit V: Diffusivity and the Mechanism of Mass Transport

5.1 Fick's law of binary diffusion (Molecular mass transport)
5.2 Temperature and pressure dependence of diffusivities
5.3 Theory of diffusion of gases at low density
5.4 Theory of diffusion in binary liquids
5.5 Theory of diffusion in colloidal suspensions
5.6 Theory of diffusion in polymers
5.7 Mass and molar transport by convection
5.8 Exercises and numerical problems

Unit VI: Concentration Distributions in Solids and Laminar Flow

6.1 Concept of shell mass balance
6.2 Concept of boundary conditions

6.3 Diffusion through a stagnant gas film
6.4 Diffusion with a heterogeneous chemical reactions
6.5 Diffusion with a homogeneous chemical reactions
6.6 Diffusion into a falling liquid film

- **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.

  Lectures: 3 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Bird R. B., Stewart W. E., Lightfoot E. N. (2006). "Transport Phenomena". 2nd Edition, Wiley & Sons.
2. Bird R. B., Stewart W. E. , Lightfoot E. N., Klingenberg D. J. (2014). "Introductory Transport Phenomena", Wiley.
3. Christie J. G. (1993). "Transport processes and unit operations". 3rd Edition. Prentice Hall.

VI CHE 486 Chemical Plant Safety and Maintenance

Course Outlines

- **Title:** Chemical Plant Safety and Maintenance
- **Code Number:** CHE486
- **Semester:** 8th
- **Credit hours:** 2
- **Pre-requisites course requirements/ skills:** CHE111, CHE121
- **Learning Outcomes:**

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

  1. Define the basic terminologies involved in chemical plant safety and maintenance.
  2. Understand various plant maintenance protocols.
  3. Identify various potential hazards and evaluate different types of hazard and perform risk assessment.
  4. Acquire knowledge related to safety rules and international standards.

- **Contents**

  Unit I: Introduction

  1.1 Concepts Definitions, Safety Program
  1.2 Types of accidents, Causes, direct and indirect effects of accidents
  1.3 Role of safety consideration in chemical plant design and Operation.
  1.4 Personal and plant protective equipment.
  1.5 Rules and regulation for prevention of accidents. Disaster control organization
  1.6 OSHA
  1.7 Process Safety Management
  1.8 Govt. regulations for industrial safety.

  Unit II: Hazards Identification:

  2.1 HAZOP study.
  2.2 Safety review and other related methods
  2.3 Safety audits
  2.4 Process hazards checklist and hazards surveys

  Unit III: Fire and Explosion

  3.1 Fire triangle and fire explosion
  3.2 Safety control mechanism

  Unit IV: Risk Assessment

4.1 Review of probability theory in respect of failures, coincidences etc. leading to unsafe situations

4.2 Fault tree analysis

Unit V: Maintenance and prevention

5.1 Types of maintenance and preventive measures

5.2 Scheduling of maintenance

- **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.

  Lectures: 2 hours per week

- **Assignments- Types and Number with calendar**

  A minimum of two assignments to be submitted before the written exam of final term

- **Assessment and Examinations**

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

- **Textbooks and reference readings**

1. Crowl, D. Y., Louvar J. F. (1990), "Chemical process safety fundamentals with applications", Prentice Hall.
2. Pandya, C. L. (1991), "Hazards in Chemical Units". Oxford ISH.
3. Grimaldi, J. H., Simonds, R. H. (1990), "Safety Management", 5th Edition, AITBS.
4. Roy, E. S. (1999), "Chemical process safety". Butterworth-Heinemann.
5. Sofronas, A. (2006), "Analytical troubleshooting of process machinery and pressure vessels: Including Real-World Case Studies", Wiley

6. Jardine, A. K. S., Tsang, A. H. C (2005), "Maintenance, replacement and reliability", CRC.
7. Hyatt, N. (2003), "Guidelines for process hazard analysis hazard identification, and risk analysis", CRC.
8. Dhillon, B. S. (2006), "Maintainability maintenance and reliability for engineers", CRC.
9. Glendon, A. I., Sharon, G. C. (2006). "Human safety and risk management", 2nd Edition, CRC.

VII CHE 487 Transport Phenomena Lab

Practicals pertaining to the course outlined in CHE485

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Note:

1. Students offered admission to B.Sc. (Engg.) Chemical Engineering with Specialization in Petroleum & Gas Technology are required to take the elective subjects related to their discipline.

2. The Institute of Chemical Engineering & Technology may make arrangements to offer international language courses of zero credit hours to interested students of B.Sc. (Engg.) Chemical Engineering and B.Sc. (Engg.) Chemical Engineering with Specialization in Petroleum & Gas Technology at times and at its own discretion.