Curriculum

for

Bachelor of Energy Engineering Technology Degree

(2023)

Higher Education Commission
Islamabad
Curriculum Division

Acronyms, Abbreviations & Definitions

Acronym/Abbreviation	Definition
NTC	National Technology Council
NCRC	National Curriculum Review Committee
IDEE	Interdisciplinary Engineering Technology course
HEI	Higher Education Institution
SMEs	Small and Medium Enterprises
PLC	Programmable Logic Controller
DIAC	Diode for Alternating Current
RIC	Resistance, Inductance, Capacitance
IEEE	Institute of Electrical and Electronics Engineers
BJT	Bipolar Junction Transistor
MOSFET	Metal–Oxide–Semiconductor Field-Effect Transistor
HEC	Higher Education Commission
Th	Theory
Lab	Laboratory
Cr. Hrs.	Credit Hours

Contents

1. Introduction

Curriculum is the total learning experience of a student that occurs in the educational process. The term refers specifically to a planned sequence of instructions, and to the student's experiences in terms of the educator's or institutions instructional goals. Curriculum is a systematic and intended packaging of competencies (i.e., knowledge, skills, and attitudes, underpinned by values) that learners should acquire through organized learning experiences.

Curriculum forges in learners' life-long learning competencies, as well as social attitudes and skills, such as tolerance and respect, constructive handling of diversity, peaceful conflict management, promotion and respect of Human Rights, gender equality, justice, and inclusiveness. At the same time, curriculum must be singularly aligned to national development goals, and produce human resources that becomes an effective factor of production in the economy.

Curriculum is thus the foundation on which rests the edifice of academic programs designed for focused outcomes that equip graduates with desired skill sets. Engineering technology curriculum aims to produce proficient engineering technology graduates who meet demands of both national and international job markets. The curriculum conforms substantially to the Sydney Accord – the international accreditation body regulating local accrediting institutions of partnering countries -- and is in consonance with the essence of Graduates Attributes and Professional Competence defined by International Engineering Alliance (IEA). [See Appendixes A through C]

Curriculum is developed and reviewed by HEC's National Curriculum and Review Committee (NCRC).

2. Curriculum Development Methodology

2.1 Benchmarking

Curriculum for Bachelor of Energy Engineering Technology is benchmarked to HEC's Undergraduate Policy and in accordance with NTC Curriculum Framework. It conforms substantially to the standards laid out by the Sydney Accord and the International Engineering Alliance pertaining to engineering technology programs [See Appendixes A through C].

The course of studies clearly defines and differentiates the program from Bachelor of Energy Engineering by contact hours spent in classrooms, laboratories, and industry.

Ideally, for engineering technology programs classroom to practical training ratio of contact hours is 30:70, providing more opportunity for hands on and psychomotor training.

2.2 Curriculum Development Cycle

Curriculum development is a rigorous process and entails the following steps:

Curriculum development is a rigorous process and entails the following steps:

- Nominations are requested from academic circles and relevant industry forums to constitute a National Curriculum Review Committee (NCRC) comprising of leading national experts.
- From the nominations received, NCRC is finalized and notified by NTC/HEC.
- A Preliminary Meeting of the NCRC, spanning three days, is held to establish framework and benchmarking issues, and assign different facets of curriculum development to smaller teams within the NCRC
- NCRC Members elect a Convenor, a co-Convenor, and a Secretary amongst themselves for the proceedings of NCRC, after mutual consultations.
- A draft of the curriculum is prepared by NCRC at the end of the Preliminary Meeting and sent to relevant foreign experts for review and feedback.
- After the foreign expert's review and feedback, a Final NCRC Meeting, lasting up to three days, is held to finalize the NCRC Members recommendations, and prepare a final curriculum document.
- The entire cycle of curriculum development is completed in two months.

2.3 Historical Timeline of Meetings

Historical Timeline of NCRC meetings to develop Bachelor of Energy Engineering Technology are enlisted below:

- Preliminary Meeting of NCRC [See Appendix D]
- Final Meeting of NCRC [See Appendix E]

3. Curriculum Details

Bachelor of Energy Engineering Technology Program			
Parameter	**HEC Framework**	**Framework - A (SIT in 7th & 8th Semesters)**	**Framework - B (SIT in 8th Semester Only)**
Program Type	Semester System	Semester System	Semester System
Program Duration	8 Semesters Min: 4 Years Max: 7 Years	8 Semesters Min: 4 Years Max: 7 Years	8 Semesters Min: 4 Years Max: 7 Years
Semester Duration	16 weeks of Teaching 2 weeks for Exams	16 weeks of Teaching 2 weeks for Exams	16 weeks of Teaching 2 weeks for Exams
Total Number of Courses	41	40	45**
Engineering Technology Domain Courses	28	28	32**
Non-Engineering Technology Domain Courses	13	12	13**
Total Credit Hours	124 – 136	133	133
Engineering Technology Domain Credit Hours	85	100	98
Percentage of Engineering Technology Domain Courses	74.42%	70%	71.11%
Non-Engineering Technology Domain Credit Hours	39	33	35
Percentage of Non-Engineering Technology Domain Courses	31.45%	30 %	28.89 %
No. of Credit Hours per Semester	15 – 18	15 – 18	15 – 18
** Optional Courses in 7th Semester shall be included for Framework B (SIT in 8th Semester only)			
1 credit hour: (1) For theory: 1 contact hour per week for a minimum of 16 weeks for theory. (2) For practical's: 3 contact hours per week for a minimum of 16 weeks for practical's.			

Engineering Technology Domain Courses in Recommended Schemes of Studies as per Framework							
Knowledge Area	**Name of Course**	**Credit Hours** (Th+Lab)	**Weekly Contact Hours** (Th+Lab)	**Total Credit Hours**		**Number of Courses**	
				As per Scheme of Studies	**As per Framework**	**As per Scheme of Studies**	**As per Framework**
Computing	Information and Communication Technology	1+1=2	1+3=4	4/ 6**	6	2/ 3**	3
	Computer Programming	1+1=2	1+3=4				
	Computing Elective **	1+1=2	1+3=4				
Energy Engineering Technology (Foundation)	Technical Drawing and CAD	0+2=2	0+6=6	21	20	9	10
	Introduction to Energy Technology	2+0=2	2+0 =2				
	Health Safety and Environment	1+0=1	1+0 =1				
	Workshop Practice	0+1=1	0+3=3				
	Electrical Circuit Analysis	2+1=3	2+3=5				
	Applied Thermodynamics	2+1=3	2+3=5				
	Electronic Devices and Circuits	2+1=3	2+3=5				
	Mechanics of Materials	2+1=3	2+3=5				
	Fluid Mechanics and Hydraulics Machinery	2+1=3	2+3=5				
Energy Engineering Technology (Breadth)	Instrumentation and Control	2+1=3	2+3=5	18	24	6	6
	Electrical Machines	2+1=3	2+3=5				
	Fuel Processing Technology	2+1=3	2+3=5				
	Power Plant Technology	2+1=3	2+3=5				
	Breadth Elective-I	2+1=3	2+3=5				
	Breadth Elective-II	2+1=3	2+3=5				
Energy Engineering Technology (Depth)	Solar Energy Technology	2+1=3	2+3=5	15 / 27**	14	5 / 9**	5
	Energy Audit and Management	2+1=3	2+3=5				
	Depth Elective-I	2+1=3	2+3=5				
	Depth Elective-II	2+1=3	2+3=5				
	Depth Elective-III	2+1=3	2+3=5				

	Depth Elective-IV**	2+1=3	2+3=5				
	Depth Elective-V**	2+1=3	2+3=5				
	Depth Elective-VI **	2+1=3	2+3=5				
	Depth Elective-VII **	3+0=3	3+0=5				
IDEE	IDTE-I	1+1=2	1+3=4	4	5	2	2
	IDTE-II	1+1=2	1+3=4				
Senior Design Project	Project Part-I	0+3=3	0+9=9	6	6	2	2
	Project Part-II	0+3=3	0+9=9				
Industrial Training	Supervised Industrial Training (Optional) 7th Semester	0+16=16	0+16=16	16**		0	
	Supervised Industrial Training (Mandatory) 8th Semester	0+16=16	0+16=16	16		0	
Total Credit Hours		133		133		133	
** Optional Courses in 7th Semester shall be included for Framework B (SIT in 8th Semester only)							

Non-Engineering Technology Domain Courses in Recommended Schemes of Studies as per Framework								
Knowledge Area	**Sub Area**	**Name of Course**	**Credit Hours** (Th+Lab)	**Weekly Contact Hours** (Th+Lab)	**Total Credit Hours**		**Number of Courses**	
					As per Scheme of Studies	**As per Framework**	**As per Scheme of Studies**	**As per Framework**
Humanities and Social Sciences	English (Expository Writing)	Communication Skills	3+0=3	3+0=3	6	6	2	2
		Technical Report Writing	3+0=3	3+0=3				
	Culture	Islamic Studies / Ethics	3+0=3	3+0=3	6	6	2	2
		Pakistan Studies	3+0=3	3+0=3				
	Social Sciences Electives	Elective-I (Professional Ethics)	3+0=3	3+0=3	3 / 5**	6	1 / 2**	2
		Elective-II (Economics)	2+0=2**	2+0=2**				
Management Sciences	Management Sciences	Elective-I	3+0=3	3+0=3	6	6	2	3
		Elective-II	3+0=3	3+0=3				
Natural Sciences	Math (Quantitative Reasoning)	Calculus and Analytical Geometry	2+0=2	2+0=2	6	6	3	2
		Differential Equations	2+0=2	2+0=2				
		Linear Algebra	2+0=2	2+0=2				
	Physics	Applied Physics	2+1=3	2+3=5	3	4	1	1
	Elective	Applied Chemistry	2+1=3	2+3=5	3	4	1	1
Total Credit Hours and Courses ** Optional Courses in 7th Semester shall be included for Framework B (SIT in 8th Semester only)					**33-35**		**12 -13**	

<table>
<tr><th colspan="2">List of Elective Topics</th></tr>
<tr><td>Social Sciences</td><td>Management Sciences</td></tr>
<tr><td>➢ Professional Ethics
➢ Economics
➢ Elective Courses by HEI*</td><td>➢ Project Management
➢ Entrepreneurship
➢ Leadership
➢ Elective Courses by HEI*</td></tr>
<tr><td>Breadth Electives*</td><td rowspan="3">Depth Electives*
➢ Hydropower technology
➢ Wind energy technology
➢ Smart grid technology
➢ Biomass energy technology
➢ Heating ventilation and air conditioning system
➢ Energy markets (3+0)
➢ Electric Vehicle technology
➢ Geothermal and ocean energy (3+0)
➢ Solar photovoltaic technology
➢ Solar thermal technology
➢ Elective Courses by HEI*</td></tr>
<tr><td>➢ Power Electronics
➢ Energy conversion and storage
➢ Power transmission and distribution
➢ Elective Courses by HEI*</td></tr>
<tr><td>Computing Electives*
➢ Data structure and Algorithms
➢ Cloud computing fundamental
➢ Machine learning
➢ Internet of things
➢ Artificial intelligence
➢ Elective Courses by HEI*</td></tr>
<tr><td colspan="2">*Any related course can be included with approval of the HEI's Statutory Bodies (maximum: 3 courses per elective knowledge area)</td></tr>
</table>

4. Admission Criteria

Criteria for admission in Bachelor of Energy Engineering Technology program is defined in NTC's Program Accreditation Policy and Procedures Manual for Engineering & Other Technologies, Clause 3.2.4.1. The salient feature for eligibility for admission are:

(1) At least 50% marks in DAE/FSc (Pre-engineering)
or other equivalent qualifications such as A-level/ICS/B.Sc. (sports and Hafiz-e-Quran marks are not included), and

(2) Entrance Test

(3) weightage:

- 70% for academics (DAE/FSc etc.)
- 30% for Entrance Test

5. Semester-wise Scheme of Studies

Semester-wise scheme of studies for Bachelor of Energy Engineering Technology program spanning 4 years, spread over 8 semesters, and totaling 133 credit hours, is presented below, along with weekly contact hours for each course.

SEMESTER-I				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ENH-111/ ENH-112	Islamic Studies / Social Ethics	Art & Humanities-I	3+0	3+0
ENE-111	Communication Skills	Expository Writing-I	3+0	3+0
ENQ-111	Calculus & Analytical Geometry	Quantitative Reasoning-I	2+0	2+0
ENN-112	Applied Physics	Natural Sciences-I	2+1	2+3
ENC-111	Information and Communication Technology	Computing-I	1+1	1+3
ENT-111	Technical Drawing and CAD	Energy Engineering Technology Foundation-I	0+2	0+6
Subtotal			**11+4 =15**	**11+12 =23**
SEMESTER-II				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ENH-121	Pakistan Studies	Art & Humanities -II	3+0	3+0
ENQ-121	Differential Equations	Quantitative Reasoning-II	2+0	2+0
ENN-121	Applied Chemistry	Natural Sciences-II	2+1	2+3
ENT-121	Workshop Practice	Energy Engineering Technology Foundation-II	0+1	0+3
ENC-121	Computer Programming	Computing-II	1+1	1+3
ENQ-122	Linear Algebra	Quantitative Reasoning-III	2+0	2+0
ENT-122	Introduction to Energy Technology	Energy Engineering Technology Foundation-III	2+0	2+0
Subtotal			**12+3 =15**	**12+9 =21**
SEMESTER-III				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ENH-211	Professional Ethics	Social Science-I	3+0	3+0
ENT-211	Electrical Machines	Energy Engineering Technology Breadth Core-I	2+1	2+3
ENT-212	Electrical Circuit Analysis	Energy Engineering Technology Foundation-IV	2+1	2+3

ENT-213	Electronic Devices and Circuits	Energy Engineering Technology Foundation-V	2+1	2+3
ENT-214	Applied Thermodynamics	Energy Engineering Technology Foundation-VI	2+1	2+3
ENT-215	Mechanics of Materials	Energy Engineering Technology Foundation-VII	2+1	2+3
Subtotal			**13+5 =18**	**13+15 =28**
SEMESTER-IV				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
ENT-221	Instrumentation and Control	Energy Engineering Technology Breadth Core-II	2+1	2+3
ENE-221	Technical Report Writing	Expository Writing-II	3+0	3+0
ENM-221	Management Science Elective-I	Management Sciences-I	3+0	3+0
ENT-222	Health Safety and Environment	Energy Engineering Technology Foundation-VIII	1+0	1+0
ENT-223	Fluid Mechanics and Hydraulics Machinery	Energy Engineering Technology Foundation-IX	2+1	2+3
ENT-224	Breadth Elective-I	Energy Engineering Technology Breadth Elective-I	2+1	2+3
ENI-221	IDTE-I	Inter Disciplinary Technology Elective-I	1+1	1+3
Subtotal			**14+4 =18**	**14+12 =26**
SEMESTER-V				**Weekly Contact Hrs. (Th+Lab)**
Course Codes	**Course Title**	**Knowledge Area**	**Credit Hrs. (Th+Lab)**	
ENT-311	Solar Energy Technology	Energy Engineering Technology Depth Core-I	2+1	2+3
ENT-312	Power Plant Technology	Energy Engineering Technology Breadth Core-III	2+1	2+3
ENT-313	Fuel Processing Technology	Energy Engineering Technology Breadth Core-IV	2+1	2+3
ENT-314	Breadth Elective-II	Energy Engineering Technology Breadth Elective-II	2+1	2+3
ENT-315	Depth Elective-I	Energy Engineering Technology Depth Elective-I	2+1	2+3
ENT-316	Project Part-I	Energy Engineering Technology Domain Project	0+3	0+9
	Subtotal		**10+8 =18**	**10+24 =34**

SEMESTER-VI				Weekly Contact Hrs. (Th+Lab)
Course Codes	**Course Title**	**Knowledge Area**	**Credit Hrs. (Th+Lab)**	
ENM-321	Management Elective-II	Management Sciences-II	3+0	3+0
ENT-321	Depth Elective-II	Energy Engineering Technology Depth Elective-II	2+1	2+3
ENT-322	Energy Audit and Management	Energy Engineering Technology Depth Core-II	2+1	2+3
ENT-323	Depth Elective-III	Energy Engineering Technology Depth Elective-III	2+1	2+3
ENI-321	IDTE-II	Inter Disciplinary Technology Elective-II	1+1	1+3
ENT-324	Project Part-II	Energy Engineering Technology Domain Project	0+3	0+9
	Subtotal		**10+7 =17**	**10+21 =31**
SEMESTER-VII				**Weekly Contact Hrs. (Th+Lab)**
Course Codes	**Course Title**	**Knowledge Area**	**Credit Hrs.** (Th+Lab)	
ENT-411	Supervised Industrial Training, or Course Work (Optional)	Energy Engineering Technology Domain Industrial Training	**16**	**40 (Per Week)**
ENH-411 ENM-411	Social Sciences / Management Sciences Elective	Social Science-II / Management Sciences-III	2+0	2+0
ENT-412	Depth Elective-IV	Energy Engineering Technology Depth Elective-IV	2+1	2+3
ENT-413	Depth Elective-V	Energy Engineering Technology Depth Elective-V	2+1	2+3
ENT-414	Depth Elective-VI	Energy Engineering Technology Depth Elective-VI	2+1	2+3
ENT-415	Depth Elective-VII	Energy Engineering Technology Depth Elective-VII	3+0	3+0
ENC-411	Computing Elective-I	Computing-III	1+1	1+3
	Subtotal		**12+4=16**	**12+12 =24**

SEMESTER-VIII				Weekly Contact Hrs. (Th+Lab)
Course Codes	**Course Title**	**Knowledge Area**	**Credit Hrs.** (Th+Lab)	
ENT-421	Supervised Industrial Training (Mandatory)	Energy Engineering Technology Domain Industrial Training	16	40 (Per Week)
Subtotal			**0+16= 16**	**0+40= 40**
Total Credit Hours & Contact Hours in Four Years (When SIT conducted in both 7th and 8th Semester)			**70+63 = 133**	**70+189=259**
Theory vs Practical's with respect to Contact Hours			Theory Practical	70 (27.03%) 189 (72.97%)
Total Credit Hours & Contact Hours in Four Years (SIT in 8th Semester only)			**82+51 = 133**	**82+153 =235**
Theory vs Practical's with respect to Contact Hours			Theory Practical	82 (34.89%) 153 (65.11%)

6. Course Codes

Details pertinent to Course Codes are presented below:

- Each course has a unique three-letter Prefix, followed by a three-digit Code.
- Letters are acronyms for course description, and numbers define the chronological position in the academic year, and sequence number in the program.
- Program duration is 4 years, with mandatory Spring and Fall semesters, with an additional Summer Semester if required.

Letters in Course Code Prefixes are defined below:

- First two letters pertain to the program (e.g., EN for energy)
- Third letter pertains to specifics of the course (e.g., T for technology, E for expository writing etc.)

Some examples of Course Code Prefixes are shown in the table below:

Digits in Course Codes are defined in the table below:

1st Digit	2nd Digit	3rd Digit
Denotes Year (1,2,3,4)	Denotes Semester (1,2,3…)	Denotes Program Sequence (1, 2, 3…)

Course Code Examples		
No.	**Course Code Prefix**	**Description**
1	EN**T**	Electrical Engineering Technology Foundation/ Breadth/ Depth
2	EN**E**	Expository Writing
3	EN**H**	Art & Humanities
4	EN**S**	Social Sciences
5	EN**Q**	Quantitative Reasoning
6	EN**N**	Natural Sciences
7	EN**C**	Computing
8	EN**M**	Management Sciences
9	EN**I**	Inter Disciplinary Technology Elective

7. Elective Courses

Lists of elective courses – grouped across depth and breadth categories – are presented below:

Elective Breadth Courses			
No.	**Course**	**Cr. Hrs.**	**Breadth**
1.	Electrical Machines	2+1 = 3	Core – I
2.	Instrumentation and Control	2+1 = 3	Core – II
3.	Power Plant Technology	2+1 = 3	Core – III
4.	Fuel Processing Technology	2+1 = 3	Core – IV
5.	Power Electronics	2+1 = 3	Elective
6.	Energy conversion and storage	2+1 = 3	Elective
7.	Power transmission and distribution	2+1 = 3	Elective

Elective Depth Courses			
No.	**Course**	**Cr. Hrs.**	**Depth**
1.	Solar Energy Technology	2+1 = 3	Core – I
2.	Energy Audit and Management	2+1 = 3	Core – II
3.	Biomass Energy Technology	2+1 = 3	Elective
4.	Hydropower Technology	2+1 = 3	Elective
5.	Wind Energy Technology	2+1 = 3	Elective
6.	Smart Grid Technology	2+1 = 3	Elective
7.	Heating, Ventilation, and Air Conditioning Systems	2+1 = 3	Elective
8.	Environmental impact assessment	3+0 = 3	Elective
9.	Energy Markets	3+0 = 3	Elective
10.	Electric Vehicle Technology	2+1 = 3	Elective
11.	Geothermal and ocean Energy	3+0 = 3	Elective
12.	Photovoltaic Technology	2+1=3	Elective
13.	Solar Thermal Technology	2+1=3	Elective

8. Course Contents

Primary goal of this curriculum is to be substantially in compliance with international standards set by relevant agencies such as the International Engineering Alliance (IEA) and the Sydney Accord (SA).

Program Learning Objectives (PLOs), Course Learning Objectives (CLOs) and Bloom's Taxonomy levels are expected Program Learning Outcomes (PLOs) and are aligned to standards set by SA and IEA.

Course Content

8.1 Islamic Studies/Social Ethics

CODE & TITLE (ENH-111/112) **Islamic Studies/Social Ethics**	**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Art & Humanities-I**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** compilation of the Holy Quran and basic concepts of Hadith.	C-2	12
CLO-2	**Understand** the basics of Islamic ideology.	C-2	8
CLO-3	**Comply** with Islam as a complete code of life.	A-2	12

Course Outline

History of Islam: Compilation of the Holy Quran and Hadith, Fundamental doctrines of Islam i.e., Tawheed, oneness of Allah, Prophet hood, the day of Judgment, Revealed books, Ibadaat (worship) Philosophy of Ibadaat, Namaz, Zakat, Hajj & Sawm, Importance of preaching of Islam, its needs and effects, Difficulties in the ways of preaching of Islam, sectarianism, its causes and effects in Muslim society, definition of Right, classification of Right, importance of Rights, Khutba Hajjatul Wida (last address of the Holy Prophet, peace be upon him), Seeratun-Nabi (Peace be upon him).

Life of Holy Prophet (Peace be upon him): The life of the Holy Prophet before and after prophet hood. The Hijra (Migration to Madina), Treaty of Al Madina, Makki and Madani life of Holy Prophet Muhammad (Peace be upon him), importance of peace and causes of terrorism.

Islam and Civilization: Definition of civilization, Impacts of Islamic civilization on the Sub-continents, international impacts of Islamic civilization, Impacts of Human thoughts, social and humanistic effects, Importance of Ethics, Human rights (Hoqooq Ul Ibad) with detail.

Knowledge and Islam: Definition of Knowledge, Classification of knowledge, Importance of technology in the light of Holy Quran and Sunnah, relevant verses of the Holy Quran about Technology (Baqara 28,30,33,201, Nahal:76, Jasia: 13, Araf: 32, Noor: 55 etc), Islamic and scientific knowledge.

Recommended Books

1. Syed. Abul Hasan Ali Nadvi, A Guidebook for Muslims, Academy of Islamic Research and Publications (3rd Edition, 2017)
2. Dr. Muhammad Hameedullah, Introduction to Islam (Latest Edition)
3. Maulana Manzoor Nomani , what is Islam? Academy of Islamic Reasearch and Publications (Latest Edition)
4. Prof. Dr. Arif Naseem, Islamiat (A standard book for CSS), (Latest Edition)

Course Content

8.2 Communication Skills

CODE & TITLE (ENE-111) **Communication Skills**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Expository Writing-I**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** basic concepts and importance of communications.	A-1	10
CLO-2	**Identify** common errors usually made by learners of English as a second language	A-2	10
CLO-3	**Follow** effective communication techniques in technical writing and presentation.	P-2	9
Course Outline			
Vocabulary building, common writing errors, purposeful writing, business writing, critical reading, reading for understanding, introduction to communication process, seven Cs of communication, types of listening, listening skills, verbal and non-verbal communication, basic presentation skills, Presentation Strategies and public speaking skills, use of Audio-Visual Aids, basics of group communication, communicate effectively in job interviews.			
Recommended Books			
1. A. J. Thomson and A. V. Martinet, Practical English Grammar, Fourth edition. Oxford University Press 2. A. J. Thomson and A. V. Martinet, Practical English Grammar Exercises 1, Oxford University Press. (Latest Edition) 3. Khaled Mohamed Al Maskari, A Practical Guide to Business Writing: Writing in English for Non-Native Speakers, Wiley. (Latest Edition) 4. Sunita Marshal and C. Muralikrishna, Communication Skills for Engineers, (Latest Edition)			

Course Content

8.3 Calculus and Analytical Geometry

COURSE CODE & TITLE (ENQ-111) **Calculus and Analytical Geometry**		**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Quantitative Reasoning-I**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-2	**Apply** techniques of differentiation and integration for solving problems	C-3	2
CLO-3	**Solve** vector calculus and analytical geometry in multiple dimensions for investigation of different technology problems.	C-3	4

Course Outline for Theory

Basic definition of derivative, differentiation of different functions, rule of differentiation, chain rule implicit differentiation, Applications: slope, equation of tangent and normal. maxima, minima and point of inflection. Indefinite integral, different technique or integration i.e. integration by parts, integration by substitution, by partial fraction, integration of different trigonometric identity. Define definite integral: Application of definite integral, i.e., Area under the curve. Area between the curve, mean value theorem, finding the volume by slicing, volume of solid revolution Disk and Washer method, moment and center of mass etc. Vector in space, vector calculus, Divergence, curl of vector field, Directional derivatives, multivariable function Partial derivatives, Spherical, polar, cylindrical coordinates. Vector in plane: Dot product and cross products, line and plane in space. Application: work, angle between two vectors, Area of triangle, Area of parallelogram etc.

Recommended Books

1. H. Anton, I. C. Bivens, S. Davis, "Calculus, Early Transcendental", John Wiley, New York 11th edition, 2016.
2. James Stewart, Essential Calculus, Cengage, 2nd Edition
3. G. B. Thomas, A. R. Finney, "Calculus", Pearson, USA, 14th edition 2017.
4. Erwin Kreyszig, Advanced Engineering Mathematics, Willey, 10th Edition

Course Content

8.4 Applied Physics

COURSE CODE & TITLE (ENN-111) **Applied Physics**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Natural Science-I**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the fundamental principles of physics.		C-2	1
CLO-2	**Solve** various problems using the laws of physics.		C-3	2
CLO-3	**Practice** the application of physics laws.		P-3	2
CLO-4	**Identify** knowledge of constructing basic circuits and demonstration of relevant theorems using Resistors and Capacitors.		P-1	2
CLO-5	**Differentiate** classroom knowledge and laboratory techniques for learning of basic principle used in Magnetism.		P-1	1
Course Outline for Theory				
Electric charge, Conductors and insulators, Coulomb's law, Electric field, Field due to a point-charge Electric dipole and line of charge, Flux of an electric field, Permittivity of a medium, Gauss's law, Application of Gauss's Law, Electric potential, calculating the potential from electric field, Potential due to a point-charge and a group of point-charges. Potential due to a dipole, Potential due to a continuous charge distribution. Capacitors, calculating capacitance, Capacitors in series and parallel, Factors affecting capacitance, Application of Capacitors. Current and Conductors, Electric current and current density, Resistance and resistivity, Ohm's law, The Steady Magnetic Field, Resistors in series and parallel, Temperature dependence of resistance and other factors affecting resistance, Application of resistors. The magnetic field, Magnetic force on a current carrying conductor, Torque on a current-loop. Magnetic field due to current, Force between two parallel current-carrying conductors, Biot Savart law and its applications, Ampere's law, Inductance and inductors, Factors affecting inductance Permeability Faraday's law of induction, Lenz's law, Energy stored in a magnetic field, Self-induction, Mutual Induction, Magnets and magnetic materials, Di-magnetic material, Para-magnetic material, Ferromagnetism.				
Lab Outlines				
Investigate the properties of series combination of Capacitors. Determine the given resistance by leakage method using ballistic Galvanometer. Study the variation of Photoelectric current with intensity of incident beam. Determine the temperature coefficient of resistance of coil by wheat stone bridge. Study Ohm's law. Investigate the properties of Series Combination of Resistances. Investigate the properties of Parallel combination of Resistances. Practical				

Demonstration of Ampere Law. Practical Demonstration of Faraday Law. Demonstrate the function of transformer as Step Up and Step-Down Transformer
Recommended Books
1. Halliday, Resnick and Walker, "Fundamentals of Physics", Willey, 10th Edition 2. Hugh D. Young and R.A. Freedman, University Physics, Addison-Wesley Professional, 12th Edition 3. Raymond A Serway and John W. Jawett, Jr. Physics for Scientists and Engineers with modern Physics, Cengage Learning, 9th Edition 4. D. Corson & Lorrain, Fundamentals of Electromagnetic Phenomenon, W.H. Freeman, 1st Edition

Course Content

8.5 Information and Communication Technology

COURSE CODE & TITLE (ENC-111) **Information and Communication Technology**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Computing-I**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** the working of computer hardware and software.		C-1	1
CLO-2	**Use** concepts of data communication and networks.		C-3	1
CLO-3	**Understand** working of hardware components of a computer.		P-1	1
CLO-4	**Enhance** problem-solving skills by developing computer programs.		P-3	2

Course Outline for Theory

Introducing Computer Systems: Basic Definitions, Computer and Communication Technology, the applications of ICT - particularly for engineering technology. Basic Operations and Components of a Generic Computer System: Basic operations: Input, Processing, output, storage Basic components: Hardware, Software, Data, Users, types of storage devices. Processing Data: Transforming data into information, how computers represent and process data, Processing Devices, CPU architectures. The Internet: The Internet and the World Wide Web- browsers, HTML, URLs/ How DNS works, Email and other programs. Introduction to Embedded Systems: What is an Embedded System, Applications, Components, Programming Languages, Popular Development Platforms. Networking Basics: Uses of networks, Common types of networks (LAN, WAN, MAN etc.), Introduction to OSI Model, Future of Networks. Database Management: Hierarchy of Data, Maintaining Data, Database Management Systems. Exposure to ICT Tools and Blogs (Student Assignment). Protecting your privacy, your computer and your data: Basic Security Concepts, threats to users, threats to hardware, threats to Data

Lab Outlines

Introduction to the very basics of the internet e.g., using search engines, using Wikipedia, checking your Email. Personal computer components, inside the CPU. Introduction to typing tutors, typing practice. Introduction to MS word. Introduction to MS Power point. Introduction to MS Excel. Introduction to HTML. Introduction to HTML codes. Writing small HTML codes. Introduction to web designing. Introduction to web designing. Introduction to programming languages. Introduction to programming languages.

Recommended Books
1. Peter Norton, “Introduction to Computers”, McGraw-Hill 7Th Edition 2. Timothy O’Leary and Linda O’Leary, “Computing Essentials”, McGraw-Hill. 28th Edition 3. Williams Sawyer, Using Information Technology: A Practical Introduction to Computers & Communications”, McGraw-Hill. 11th Edition 4. Shelly GB, Vermaat ME, “Discovering Computers, Complete: Your Interactive Guide to the Digital World. Cengage Learning”, 1st Edition)

Course Content

8.6 Pakistan Studies

COURSE CODE & TITLE (ENH-121) **Pakistan Studies**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Art & Humanities-I**
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the difference between ideological and non-ideological states.		C-2	6
CLO-2	**Discuss** Pakistan Movement, and political and constitutional history of Pakistan.		C-2	6
CLO-3	**Analyze** the current issues of Pakistan.		C-4	6

Course Outline for Theory

Pakistan ideology: Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah, Aims and objective of the creation of Pakistan. Indus Civilization, Location and Geo-Physical features, Reformist Movement in Subcontinent. Muslim League 1906, Lahore Resolution 1940, 3rd June plan and Independence 1947, Constitution and Law, Constitutional Assembly, Nature and Structure of Constitution, Features of 1956, 1973 Constitutions. Amendments in the Constitution (17th, 18th, 19th and 20th), Foreign Policy, Objectives, Contemporary Pakistan, Economic institutions and issues, Society and social structure, Ethnicity, Determinants of Pakistan Foreign Policy and challenges, Futuristic stance of Pakistan

Recommended Books

1. Amin, Tahir, Ethno – National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad, 1st Edition
2. Afzal, M. Rafique, Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research
3. Mr. Ishtiaq Hussain Qureshi, Struggle for Pakistan, Bureau of Composition, Compilation, and Translation UoK Karachi

Course Content

8.7 Differential Equations

COURSE CODE & TITLE (ENQ-121) **Differential Equations**		**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Quantitative Reasoning-II**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Solve** differential equations of first and higher-order homogenous and non-homogenous differential equations.		C-3	1
CLO-2	**Analyze** linear differential equations using the Laplace Transform technique and power series methods.		C-4	1
Course Outline for Theory				
Basic concept of differential equation, I.e., Definition, order, degree, and geometric meaning of Diff: equation. Solution of First order Diff Equation: Separable of equation, Exact Diff: Equation, integrating Factor, Linear ODEs. Second and higher order Differential Equation: Homogenous linear ODE with constant coefficient, Cauchy Euler Equation. Non homogenous Equation by undetermined coefficient, by variation of parameter and similar higher order Diff. equation. Finding Laplace and inverse Laplace of different function, S- shafting theorem, solution of differential equation using Laplace transform. Basic concept of power series, Radius of convergence, convergence interval, using power series method to find the solution of Differential Equation.				
Recommended Books				
1. Erwin Kreyszig, Advanced Engineering Mathematics, Willey 2014 2. W. E. Boyce, R. C. DiPrima, "Elementary Differential Equations and Boundary Value Problems, 10th edition", John Wiley & Sons, Inc., 2012 3. D. G. Zill, M. R. Cullen, "Differential Equations with Boundary-Value Problems", 10th edition, Brooks/Cole, 2013				

Course Content

8.8 Computer Programming

COURSE CODE & TITLE (ENC-121) **Computer Programming**		**CREDIT & CONTACT HOURS** (1+1) **16 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Computing-II**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand,** and be proficient in C++.	C-1	1
CLO-2	**Apply** gained knowledge in C++ to analyze and solve problems effectively.	C-3	2
CLO-3	**Identify** difference between procedural and object-oriented paradigms.	C-1	1
CLO-4	**Illustrate** the use of Integrated Development Environment (IDE) specially Code Blocks for writing and compiling programs.	P-2	1
CLO-5	**Write,** compile, and remove errors in programs.	P-3	2

Course Outline for Theory

Introduction to the course, C++ and the IDE. Data types and operators. Functions. Conditions (if, if-else, nested if-else). Conditions (switch statement, conditional operator). Recursion. Iteration (for loop, while, do-while). Iteration (do-while). Strings. File handling Structures. Arrays, Sorting Arrays and passing arrays to functions. Pointers. Calling functions by reference. Introduction to classes and objects.

Lab Outlines

Introduction to C++. Arithmetic operations. Repetitive statements/loops. Functions. Recursion. Arrays- one dimensional. Sorting algorithms. Arrays – 2 dimensional. Strings. Pointers. Open ended Lab

Recommended Books

1. Deitel & Deitel, C++ How to Program, Prentice Hall, 10th Edition
2. Walter Savitch, Problem Solving with C++, latest Edition, Addison Wesley, 9th Edition
3. Guttag V. John, Introduction to Computation and Programming Using Python: With Application to Understanding Data, 2nd Edition
4. Mike McGrath, "C++ programming, In Easy Steps Limited; 5th edition

Course Content

8.9 Professional Ethics

COURSE CODE & TITLE (ENH-211) **Professional Ethics**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Social Science-I**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Comprehend** the basic concepts of personal and professional ethics.		C-2	8
CLO-2	**Respond** to ethical dilemmas using common ethical values.		A-2	8
CLO-3	**Adopt** ethical principles at all professional levels.		A-3	8

Course Outline for Theory

Introduction: Introduction to ethics, personal and professional ethics, the nature of engineering ethics; legal, professional and historical definitions; origin of professional ethics, profession and professionalism; professional accountability, professional success, professional risks, professional associations; benefits of acting ethically and consequences of acting unethically. Value of Ethics: Values in professional ethics, central responsibility of engineering professionals, ethics in different fields of work, IEEE code of ethics, ethical code for engineering professionals, global issues in professional ethics, ethics in manufacturing and marketing, intellectual property rights, business ethics and corporate governance. Ethical Dilemmas: Common ethical dilemmas, resolution of ethical dilemmas, possible actions in response to dilemmas, probable consequences of these actions.

Recommended Books

1. Charles E. Harris, Engineering Ethics Concepts & Cases, Cengage, 5th Edition, Cengage 2014
2. Mike W. Martin, Roland Schinzinger, Ethics in Engineering, McGraw-Hill, New York, 2005 4th Edition
3. Stephan r. Covey, The Seven Habits of Highly effective people

Course Content

8.10 Technical Report Writing

COURSE CODE & TITLE (ENE-221) **Technical Report Writing**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Expository Writing-I**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the basics of technical report writing process.		C-2	10
CLO-2	**Demonstrate** proficiency in writing various technical reports.		C-3	10
CLO-3	**Communicate** effectively using ICT tools.		A-2	12
Course Outline for Theory				
Introduction to technical writing, technical communication process, proposal write-up and improvement strategies, introduction to research and research types, choosing research problems and research advisors, how to carry out research, different parts of technical writing, formulation – problem statement, literature review, design – methodology, analysis - data analysis and interpretation good writing style techniques, uses of correct words, presenting and publishing research, write business/professional correspondence, cover letter and CV, writing meeting minutes, introduction to informal writing, uses of informal reports.				
Recommended Books				
1. Daniel Riordan, Technical Report Writing Today, Cengage 10th Edition 2. Leslie Olsen and Thomas Huckin, Technical Writing and Professional Communication,McGraw Hill , 2nd Edition 3. J. W. Davies, Communication for Engineering Students, Prentice Hall, 3rd Edition 4. Hilary Glassman-Deal, Science Research Writing for Non-Native Speakers of English, Imperial College Press				

Course Content

8.11 Linear Algebra

COURSE CODE & TITLE (ENQ-122) **Linear Algebra**		**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Quantitative Reasoning-III**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** basic definitions, properties, and theorems of linear algebra.		C-2	1
CLO-2	**Solve** systems of linear equations using matrices.		C-3	1
Course Outline for Theory				
System of linear equations, row reduction and echelon forms, vector equations, the matrix equation ax=b. Solution sets of linear systems, applications of linear systems. Concept of matrices, types of matrices, operation on matrices i.e., addition, subtraction, multiplication, properties of matrix operation, the elementary row operation, echelon form, solution of linear system of equation by gauss elimination method, concept of consistent and inconsistent solution, polynomial interpolation. inverse of matrix using Gauss-Jordon method. Determinant of matrix: definition and properties of determinants and their theorem, concept of singular and nonsingular matrix, solution of non-homogenous linear system of equation using Cramer's rule. Introduction to linear transformation, daily life application i.e., cryptography example coding and decoding the messages, computer graphic.				
Recommended Books				
1. Bernard Kolman, Introductory Linear Algebra, Pearson, 9th Edition 2. Erwin Kreyszig, Advanced Engineering Mathematics, Willey, 10th Edition 3. D. C. Lay, S. R. Lay, J. J. McDonald, "Linear Algebra and Its Applications", Pearson Education 5th Edition 4. Gilbert Strang, Linear Algebra and its Applications, Cengage, 4th Edition				

Course Content

8.12 Economics

COURSE CODE & TITLE (ENH-411) **Economics**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Management Science-I**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Calculate** asset depreciation and its impact on income tax calculations.		C-3	11
CLO-2	**Analyze** profitability of potential investment opportunities by incorporating time-value of money.		C-4	11
CLO-3	**Assess** business health by performing ratio analysis on financial statements.		C-5	11

Course Outline for Theory

Basic concepts, technological economy defined Types of Business organizations, financial statements and financial ratios, Time value of money, cash flow series and its types, basic cost concepts. Profit and interest, discrete and continuous compounding, nominal, and effective interest rate. Economic analysis of alternatives, Alternatives having identical lives, Alternatives having different lives, PW, AW, FW, Cost-benefit analysis and rate of return analysis, Break-even and payback analysis. Use of spreadsheets for economic analysis, economic effects of inflation. Replacement and retention decisions Depreciation, amortization, and depletion of economic resources. Price, Supply and Demand Relationship. Project financing. Factors of production, Capital budgeting, economic analysis in the service sector.

Recommended Books

1. Shoubo Xu, Technological Economics, Springer, 1st Edition
2. Leland T. Blank and Anthony J. Tarquin, Engineering Economy, McGraw Hill, 5th Edition
3. Chan S Park, Contemporary Engineering Economics, Pearson Prentice Hall 6th Edition
4. Donald G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, Engineering Economic Analysis, Oxford University Press, 12th Edition

Course Content

8.13 Entrepreneurship

COURSE CODE & TITLE (ENM-221) **Entrepreneurship**		CREDIT & CONTACT HOURS (3+0) **48 Theory + 0 Lab**	KNOWLEDGE AREA/ DOMAIN **Management Science-II**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** creativity, innovation, explain the process of idea assessment, and perform feasibility analysis.		C-1	6
CLO-3	**Describe** different types of ownerships, franchising, and the role of e-commerce in small businesses.		C-2	12
CLO-2	**Prepare** a business plan with an appropriate business model, and a marketing plan.		C-3	11

Course Outline for Theory

The concept of entrepreneurship, the economist view of entrepreneurship, the sociologist view, Behavioral approach, Entrepreneurship and Management. The process of entrepreneurship, Entrepreneurial Management, The entrepreneurial business, Entrepreneurship in service institutions, the new venture. The innovation concepts, Importance of innovation for entrepreneurship, Sources of innovative opportunities, the innovation process, Risks involved in innovation. Entrepreneurial profile, Trait approach to understanding entrepreneurship, Factors influencing entrepreneurship, the environment, Socio cultural factors, Support systems. Teamwork, Networking organization, Motivation and compensation, Value system. Defining SMEs, Scope of SMEs, Entrepreneurial, managers of SME, Financial and marketing problems of SMEs, Framework for developing entrepreneurial marketing, Devising entrepreneurial marketing plan, Entrepreneurial marketing strategies, Product quality and design, Role of entrepreneur in the economic development generation of services, Employment creation and training, Ideas, knowledge and skill development, The Japanese experience, Case Studies of Successful Entrepreneurs

Recommended Books

1. Richard Dorf, Andrew Nelson, Technology Ventures: From Idea to Enterprise by Thomas Byers, McGraw Hill, 4th Edition
2. Paul Burns and Jim Dew Hurst, Small Business and Entrepreneurship, Palgrave Macmillan Publishing Company, 2nd Edition
3. Peter F. Drucker, Innovation and Entrepreneurship, Harper Business, 1st Edition
4. Steve Blank, Bob Dorf, K & S Ranch, The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, Wiley, 1st Edition

Course Content

8.14 Project Management

COURSE CODE & TITLE: (ENM-321) **Project Management**		**CREDIT & CONTACT HOURS** (2 Th + 0 Lab) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/DOMAIN** **Management Science -III**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the basic functions of management with a special focus on Project Management.	C-2	11
CLO-2	**Apply** knowledge areas of Project Management.	C-3	11
CLO-3	**Employ** ICT technologies in Project Management such as MS-Project and Primavera etc.	P-3	5

Course Outline

Introduction to Management: History of management, functions and functional areas of management, levels of management, managerial skills, types of organizations, managerial control, principles of management. Introduction to Project Management: Definition of Project and Project Management, knowledge areas of project management, project life cycle, project characteristics, project constraints, project organization structure. Project Quality Management: History of Quality Management, defining quality, relationship between project management and quality management, Quality Management Frameworks.

Project Stakeholder Management: The roles of project manager and project sponsor, project team selection, skills, and competencies of project manager, building and managing successful project teams, stakeholder management .Project Cost Estimating and Budgeting: Cost components and methods for cost estimation in projects, cost control in projects, life cycle cost, cost scheduling and forecasting, project resource allocation and levelling, estimation of outstanding work, elements of budgets and estimates, earned value management.

Project Risk Management: Defining risk and uncertainty, business and project risk, probability and impact of risk, risk management process. Project Time Management: Introduction to project scheduling, Critical Path Method, network representation of projects, critical activities, and critical path, project Gantt Chart. Project Closure: Project evaluation, project and project management success, success criteria for projects, project audits, project termination process. Project Management Tools: Introduction and use of project management tools like MS Project and Primavera.

Recommended Books
1. Harold Kerzner, Project Management: A System Approach to Planning Scheduling and Controlling, John Willey, 11th Edition 2. Jack R. Meredith and Samuel J. Mantel, Jr. John, Project Management: A managerial approach, Wiley and Sons, Inc., 7th Edition 3. John M. Nicholas and Herman Steyn, Project Management for Engineering and Technology: Principles and Practice, Elsevier Publications, 3rd Edition 4. Paul Gardiner, Project Management: A Strategic Planning Approach, Palgrave Macmillan, 2nd Edition

Course Content

8.15 Workshop Practice

COURSE CODE & TITLE (ENT-121) **Workshop Practice**		**CREDIT & CONTACT HOURS** (0+1) **0 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Energy Engineering Technology Foundation**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Use** basic tools in various shops to enhance associated hands-on skills.		P-3	1
CLO-2	**Demonstrate** basic operations of tools in Electrical and Mechanical Workshops.		P-4	2
CLO-3	**Participate** actively in performing experiments on different machines, following all safety precautions.		A-2	8
Lab Outline				
Objective: This lab aims to impart the students hands-on experience on different equipment in workshops. Besides giving them insight about machines operations, and tools utilizations, similarly wood working technology, tools and applications for pattern making. Understanding and applications of different measuring and gauging instruments. Performing foundry operations such as forging and casting. Hands-on joining operations such as different welding processes, fastening, riveting and adhesive bonding. Basics of lathe & milling operations, drillings and cutting etc.				
Recommended Books				
1. W A J Chapman, Workshop Technology Part-I, Butterworth-Heinemann, 5th Edition, 1972. 2. Wiring Manual, Pak Cables Limited. ME-201 ENGINEER 3. **H P Schwan, Electrical Wiring, McGraw Hill, 14th Edition, 1982.** 4. Amin ur Rasheed Noordin, Proteus Professional Design, 2011				

Course Content

8.16 Technical Drawing and CAD

COURSE CODE & TITLE (ENT-111) **Technical Drawing**		**CREDIT & CONTACT HOURS** (0+2) **0 Theory + 96 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Energy Engineering Technology Foundation**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Recognize** basic tools and shapes of engineering drawings.		P-1	1
CLO-2	**Use** engineering drawing tools and their principles to represent engineering drawing models.		C-3	5
CLO-3	**Draw** 2D and 3D sketches using CAD tools.		P-4	10

Lab Outlines

Mechanical Drawing: Use of drafting instruments. Basic drafting techniques, drawing and lettering, dimensioning, projections and section of solids, orthographic projections, isometric views with reference to piping and ducting, practice of assembly drawing. Civil drawing: plan, elevations (front, left and right) and details of buildings. Elements of perspective drawings. Electrical Drawing: Electrical safety drawings, electric substation equipment layout, schematic diagrams of substations, lighting, and power distribution boards in contrast with house and industrial wiring diagrams, electrical symbols and one-line diagrams of a typical power system and its parts using all details.

The CAD tools will also be introduced to students for familiarization with Computer Aided Designing such as AutoCAD, ProE or any other similar software.

Recommended Books

1. Frederick Giesecke, Alva Mitchell, Henry Spencer Technical Drawing with Engineering Graphics, The Macmillian Company, 15th Edition, 2016
2. Gary Bertoline, Eric Wiebe, Nathan Hartman, William Ross, Technical Graphics Communication 4th Edition, 2008
3. David F. Rogers, James A. Adams; Mathematical Elements for Computer Graphics, McGraw-Hill, 1990.

Course Content

8.17 Electronic Devices and Circuits

COURSE CODE & TITLE (ENT-213) **Electronic Devices and Circuits**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Energy Engineering Technology Foundation**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the basic construction, operation and characteristics of semiconductor devices and their circuits.		C-2	1
CLO-2	**Apply** small and large signal models for amplifiers gain analysis.		C-3	2
CLO-3	**Measure** characteristics of semiconductor devices.		P-3	2
CLO-4	**Follow** safety rules and regulations for electrical equipment usage.		A-3	6

Course Outline for Theory

Study formation of PN junction from semiconductor materials and diodes circuits and its application in different areas. Study the AC/DC configuration of bipolar junction transistor (BJT). Study of FETs and MOSFETs; operation and applications. Introduction to Operational Amplifiers and its applications.

Lab Outline

This lab course explains the basic concepts of semi-conductor diode and its current-voltage relationship. Various applications of junction diode are discussed, and various types of diodes are also explained. Different configurations of Bipolar Junction Transistors (BJTs) amplifiers are discussed. Relations of various currents and voltages in these transistors are explained in detail. Configuration of FETs and MOSFETS circuits. The course is directly supported with lab experiments embracing the design principles.

Recommended Books

1. Robert Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 11th Edition, 2012.
2. Thomas L. Floyd, Electronic Devices, Pearson, 10th Edition, 2018.
3. Alberto P. Malvino, David Bates, Electronics Principles, 8th Edition, 2015.
4. B.L Theraja and A.K Theraja, Electrical Technology, 23rd Edition, 2002.

Course Content

8.18 Electrical Circuit Analysis

COURSE CODE & TITLE (ENT-212) **Electrical Circuit Analysis**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Energy Engineering Technology Foundation**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** basic concepts, laws, and theorems used for circuit analysis.	C-2	1
CLO-2	**Describe** the transient response of energy storing elements.	C-3	2
CLO-3	**Demonstrate** AC circuits using theorems and steady state response of reactive elements.	P-4	2
CLO-4	**Understand** RLCs, transient, and resonance response of series and parallel circuits, by using modern tools and simulators, e.g. P-Spice.	P-3	5
CLO-5	**Work** as a team member to accomplish given tasks.	A-2	9

Course Outline for Theory

Basic Concepts: Voltage, Current, Power and Energy. Independent and Dependent Sources. Series and Parallel Combinations of Elements, Voltage Division and Current Division. Networks Laws: KVL, KCL, Node Analysis, Mesh Analysis, Current & voltage divider rules. Network Theorems: Thevenin's Theorem Norton's Theorem, superposition Theorem.

Capacitance: Permittivity expression for capacitance, charging and discharging, parallel and series connection of capacitors. AC Fundamentals: RMS, Average and Maximum values of current and voltage for sinusoidal signal wave forms, Introduction to phasor representation of alternating voltage and current.

Complex Numbers: Complex Exponential Representations of Sinusoids (Phasors), Impedance and Admittance, Sinusoidal Steady-State (SSS) Analysis. Power Analysis: Instantaneous and Average Power Complex Power, Maximum Power Transfer, Power Factor, Power Factor and Power Factor correction.

RL, RC and RLC circuit analysis with Ac excitation. AC circuit power analysis with RL, RC and RLC circuit. Analog filters: Low pass, high pass, band pass and stop band filter. Transient analysis: Transient analysis of series and parallel circuits. Laplace Transform for the analysis of linear time-invariant networks will be made - poles, zeros, and frequency response. The concept of Polyphase and Resonance Circuits. Transient Analysis with DC Excitations. Determine the unknown parameters of two-port circuits

Lab Outline
Simulate RL, RC and RLC Circuits transient response in P- Spice. Implement circuits using R, RL and RC and verify the node voltages and loop currents using instruments. Verify Circuit-theorems using lab instruments. Verify circuit transformations using lab instruments broadly defined Engineering Technology Problems. Learn the use of basic instruments in electrical circuit analysis: Multimeter, Voltmeter, Ammeter. Implementation of resistive circuits; series, parallel, KVL and KCL. Verify Circuit-theorems using lab instruments. Verify circuit transformations using lab instruments broadly defined Engineering Technology Problems.
Recommended Books
1. D. Irwin and R. M. Nelms, Basic Engineering Circuit Analysis, Wiley, 9th Edition, 2008. 2. Robert L. Boylestad, Introductory Circuit Analysis, Amazon, 12th Edition, 2012. 3. Alexander and M. Sadiku, "Fundamentals of Electric Circuits", McGraw-Hill, 4th Edition, 2008. 4. James S. Kang, PSpice manual for Electric Circuits Fundamentals, Oxford University Press, 1995.

Course Content

8.19 Introduction to Energy Engineering Technology

COURSE CODE & TITLE (ELT-122) **Introduction to Energy Engineering Technology**		**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Energy Engineering Technology Foundation**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the fundamental characteristics and mechanisms of various energy sources.		C-2	1
CLO-2	**Compare** traditional energy and renewable energy sources to assess their impact on the environment and society.		C-2	7
Course Outline for Theory				
Introduction to Renewable Energy Systems: Word and Pakistan Energy Scenario, Types of Renewable Energy Technologies, Classifications of wind and solar systems best locations for Solar and wind Energy systems. Designing of Wind and Solar Energy systems, Weibull probability distribution and TSR Speed-Power relations and designing of blades, Power vs speed Blade designing. Designing of Solar System Designing of parameters for maximum efficiency of solar systems, Types of solar cells and losses, Design of parameters for a high efficiency solar cell, Heterojunction, thin films and other promising solar cells. Costing of Renewable Energy Systems, Capital cost of system, Payback period, Maintenance Cost. Grid Connected Systems: Exploitation of Alternate energy sources, Review of present energy state of energy sector, Different sources of energy, Components of power systems, Energy crises. Problems in energy sector: WAPDA's Plan, Short term and long-term measures. Distributed generation Resources and their economics: Fossil fuels, Tidal, Ideal and practical values, Demand charges, Electricity utility rates.				
Recommended Books				
1. Efstathios E. Stathis Michaelides, Alternative Energy Sources (Green Energy and Technology), 2012. 2. Bent Sorensen, Renewable Energy: Physics, Engineering, Environmental Impacts, Economics and Planning, Academic Press, 5th Edition, 2017. 3. Aldo V. da Rosa, Juan C. Ordonez, Fundamental of Renewable Energy Process, Academic Press, 4th Edition, 2021. 4. Bent Sorensen, Renewable Energy Conversion, Transmission, and Storage, Academic Press, 1st Edition, 2007.				

Course Content

8.20 Mechanics of Materials

COURSE CODE & TITLE (ENT-215) **Mechanics of Materials**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Energy Engineering Technology Foundation**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** mechanical behavior of materials under tensile, compressive, torsional, and combined loadings.		C-2	1
CLO-2	**Solve** problems related to structural members under various loading conditions.		C-3	2
CLO-3	**Perform** experiments to determine various properties of materials.		P-3	2
CLO-5	**Contribute** as a team member for accomplishing given tasks.		A-2	9

Course Outline for Theory

The concept of stress and strains under direct and transverse loading conditions. Stress-strain diagram, poison's ratio, Factor of safety. Understand the Mechanical properties of Different materials under various loading conditions. Failure due to axial loading in beams, bars, columns etc. Description of strength, resilience, toughness, and fracture under tensile and compressive loadings. Concept of area moment of inertia and polar mode of inertia. Torsion, design of shaft and its failure due to torsional loads. Determination of bending stresses and deflection in different types of beams under various loading conditions.

Lab Outline

Determine the behaviours of the materials under various loading conditions, various mechanical properties like strength, toughness, stiffness etc.; Determine of hardness of materials by using Brinell Hardness, Vicker hardness and Rockwell Hardness testing etc.; the effects of creep, and fatigue on different materials; deflection of various types of beams under different loading conditions, Impact load using Charpy/Izod testing machines. Find the modulus of elasticity (E), modulus of rigidity (G), shear stress (τ) for a given shaft specimen in torsion.

Recommended Books

1. James L. Meriam, L.G. Kraige, Engineering Mechanics: Dynamics, John Wiley & Sons, 8th Edition, 2015.
2. R. C. Hibbeler. Engineering Mechanics: Dynamics, Prentice Hall, 13th Edition, 2012.
3. Ferdinand Beer, E. Russell Johnston Jr., David Mazurek, Vector Mechanics for Engineers: Statics, McGraw-Hill Education, 10th Edition, 2012.
4. Ferdinand Beer, E. Johnston, John DeWolf, David Mazurek, Mechanics of Materials, McGraw Hill, 8th Edition, 2019.
5. James M. Gere, Barry J. Goodno, Mechanics of Materials, Cengage Learning, 8th Edition, 2012.

Course Content

8.21 Applied Thermodynamic

COURSE CODE & TITLE (ENT-214) **Applied thermodynamic**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Energy Engineering Technology Foundation**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** thermodynamics systems and its components such as diffusers, turbines, and nozzles.		C-2	1
CLO-2	**Solve** problems related to vapor and gas, positive displacement, and roto-dynamic machines.		C-3	2
CLO-3	**Perform** experiments of different thermodynamic systems.		P-3	4
CLO-4	**Participates** actively as a team member for practical tasks.		A-2	9

Course Outline for Theory

Thermodynamic systems, Thermodynamic properties, Laws of Thermodynamics and applications, Energy and work, Properties of vapor and steam, Properties of ideal and real fluid and their relationships, Applications of thermodynamic principles to fluids, Closed and Open systems, Thermodynamics cycles (Carnot Cycle, Otto Cycle, Diesel Cycle, Dual Combustion Cycle, Rankine Cycle, Brayton Cycle) and application, Fuel and Combustion: calorific values, air fuel ratio, chemical equation and conservation of mass in a combustion process, Nozzles, Diffusers, Compressors and, Steam and Gas turbines, Heat balance sheet for thermal systems.

Lab Outline

Study of working principal of external combustion engine, internal combustion engine, measure indicated and brake horsepower of an IC engine, draw the heat balance sheet of internal combustion engine, working principal of water tube and fire tube boilers, measure the isentropic efficiency of steam turbine, draw the performance characteristics of a compressor, pressure curves of a diffuser, determine the critical ratio of a nozzle and calorific value of different fossil fuels.

Recommended Books

1. T. D. Eastop, A. McConkey. Applied Thermodynamics for Engineering Technologists, 4th Edition. Pearson Education, 2009.
2. R.E. Sonntag, C. Borgnakke, G.J. Van Wylen, Fundamentals of Thermodynamics. 6th Edition. John Wiley, 2003.
3. G.F.C. Rogers, Y.R. Mayhew, Engineering Thermodynamics Work and Heat Transfer. 4th Edition. Pearson Education, 2003.
4. J.P. Howell, P.O. Buckius, Fundamentals of Engineering Thermodynamics. McGraw-Hill, 1992.
5. Y.A. Cengel, M.A. Boles, Thermodynamics, An Engineering Approach, 4th Edition. Tata McGraw-Hill, 2003.

Course Content

8.22 Fluid Mechanics and Hydraulic Machinery

COURSE CODE & TITLE (ENT-223) **Fluid Mechanics and Hydraulic Machinery**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Energy Engineering Technology Foundation**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the fundamental properties of fluids and hydraulic machinery.		C-2	1
CLO-2	**Solve** problems related to various hydraulic machines.		C-3	2
CLO-3	**Perform** experiments of various fluid properties and hydraulic systems.		P-3	4
CLO-4	**Participates** actively as a team member for practical tasks.		A-2	9
Course Outline for Theory				
Fluid Properties: Introduction, Fluid, Units and Dimensions, Density, Specific Volume, Specific Weight, Specific Gravity, Viscosity, Vapor Pressure, Surface Tension, Capillary Action and Compressibility of Fluids. Fluid Statics: Pressure at a Point, Pressure Variation in a Static Fluid, Hydrostatic Paradox, Aerostatic Law, Standard Atmosphere, Absolute Pressure, Gauge Pressure, Vacuum Pressure, Barometer, Pressure Measuring Devices. Fluid Kinematics: Methods Describing Motion of Particles, Types of Fluid Flow, Equation of Continuity, Flow Visualization, Velocity and Acceleration, Velocity Potential, Stream Function, Flow Net. Fluid Dynamics: Euler's Equation of Motion, Bernoulli's Equation, Bernoulli's Equation for Real Fluids, Venturimeter, Orifice meter, Pitot Tube, Nozzle Meter, Free Liquid Jet, Impulse Momentum Equation, Moment of Momentum Equation, Forced Vertex, Free Vertex. Hydraulic Machinery - Turbines: Layout of Hydroelectric Power Plants, Heads of Turbine, Classification of Hydraulic Turbines, Efficiency of a Turbine, Pelton Turbine, Reaction Turbine				
Lab Outline				
Study of Hydraulic Bench. Determine the co-efficient of Venturi meter & discuss its application, calibrate the given rectangular notch and discuss its application, calibrate a triangular notch and discuss its application, find the co-efficient of discharge, calibrate the given pressure gauge & discuss its application. Study the impact of jets on vanes, performance characteristics of centrifugal pump, characteristic curves of Francis turbine and hydraulic ram at constant valve lift and constant supply head.				

Recommended Books
1 . B.R. Munson, D.F. Young, T.H. Okiishi, and W.H. Huebsch, Fundamentals of Fluid Mechanics. John Wiley & Sons, 6th Edition, 2009.
2 . J.F. Douglas, J.M. Gasiorek, J.A. Swaffield, and L.B. Jack, Fluid Mechanics, Pearson, 5th Edition, 2005.
3 . M.K. Goyal, Fluid Mechanics and Hydraulic Machines. PHI Learning, 2015.
4 . S.K. Som, G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, McGraw-Hill, 2nd Edition, 2008.
5 . Y. Nakayama, R.F. Boucher, Introduction to Fluid Mechanics, Butterworth-Heinemann, 1999.

Course Content

8.23 Health, Safety, and Environment

COURSE CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(ENT-222) **Health, Safety, and Environment**	(2+0) **32 Theory + 0 Lab**	**Energy Engineering Technology Foundation**

	After completion of this course, students will be able to:	**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** societal health and safety issues.	C-2	6
CLO-2	**Describe** the impact of technology on the environment in assessing the outcome considering sustainable development.	C-2	7

Course Outline for Theory

Introduction of Health, Safety & Environment: Introduction & objectives of Safety, Importance of Safety in an industry, Industrial accidents, Types of accidents, Effects of accidents, Green House Gases, Global Warming.

Principles of accident prevention: Hazards and its types, Risk, Sources of Risk, Risk Assessment, Risk Matrix, Personal Protection Equipment (PPEs), Safety Management and Hierarchy of Control, Safety training, First aid and emergency procedures, Ergonomics.

Fire Safety: Chemistry of Fire, Fire Triangle, Types of Fire, Fire prevention and control, Fire Extinguishers, PASS rule for Fire Extinguishers.

Environmental Acts: Legal, humanitarian and economic reason for action, Pakistan Health and Safety Act, OHSAS 18001, Environmental Management system ISO 14001, ISO Standards for Safety, Health and Environment

Pollution and its Types: Atmospheric Pollution & types of Atmospheric pollution, Causes and Effects of Atmospheric Pollution on Human Health Available Technologies for Controlling Pollution, Industrial Waste, Solid Waste, Industrial Effluents and Waste Gases, Waste treatment plants, Noise Pollution, Measurement of Noise level, Effect of excessive noise on human health, Remedial Measures.

Recommended Books

1. John Ridley, John Channing, Safety at Works, 7th Edition, Butterworth-Heinemann, 2007.
2. K. G. Lockyer, Factory & Production Management, Pitman Publishers, 3rd Edition, 1974.
3. Allan St John Holt, Jim Allen A.S.J Holt, Principles of Health and Safety at Work, Routledge, 8th Edition, 2015.
4. George D. Clayton, Florence E. Clayton, Patty's Industrial Hygiene and Toxicology, Vol. 1, Part A, General Principles, Wiley-Interscience, 4th Edition, 1991.

Course Content

8.24 Electrical Machines

COURSE CODE & TITLE: (ENT-211) Electrical Machines		CREDIT & CONTACT HOURS (2+1) 32 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Energy Engineering Technology Breadth	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** fundamental theories and concepts related to Electromagnetic Circuits applied to Electrical Machines.		C-2	1
CLO-2	**Solve** equivalent circuits and related problems of electrical machines.		C-3	1
CLO-3	**Observe** the various parameters of DC generators and motors, their equivalent circuits, the relationships between speed, power, torque, and their applications.		P-1	2
CLO-4	**Conduct** experiments to investigate performance of electrical machines.		P-2	4
CLO-5	**Respond** actively as an individual, as well as in a team, to implement safety procedures during practice in the lab.		A-3	9

Course Outline for Theory

DC Motors: Introduction and fundamental concepts, working principle, types, construction, operation, EMF equations, torque equations, characteristics, commutation, armature reaction, speed and voltage regulation, losses, open and short circuit test, no load and blocked rotor test, nameplate ratings and applications. Transformers: Introduction and fundamental concepts, working principle, types, construction, ideal transformer, operation and equivalent circuit, voltage regulation, losses, open and short circuit test, efficiency, instrument and auto transformers, nameplate ratings and applications. Induction and Synchronous Machines: Introduction and fundamental concepts, working principle, rotating magnetic field, magneto motive force and flux distribution, types, construction, operation, EMF equations, torque equations, speed and voltage regulation, losses, open and short circuit test, no load and blocked rotor test, nameplate ratings and applications. Fractional-Horsepower Motors: Hysteresis Motors, Stepper Motors, Universal Motors, Brushless DC Motors, etc.

Lab Outline

Basic Principle of Machine. Single and Three Phase Transformers. DC Generator and Motor. Induction and Synchronous Machines

Recommended Books

1. Theodore Wildi, Electrical Machines, Drives, and Power Systems, Pearson, 2005.
2. Stephen J. Chapman, Electric Machinery Fundamentals, McGraw-Hill, 2011.
3. J. Hindmarsh "Electrical Machines And Their Applications, PERGAMON,OXFORD, 1984.

Course Content

8.25 Instrumentation and Control

COURSE CODE & TITLE (ENT-221) **Instrumentation and Control**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Energy Engineering Technology Breadth**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the fundamentals of instrumentation, measurement, and control systems.		C-2	1
CLO-2	**Illustrate** the control model of electrical, mechanical, and chemical energy systems.		C-3	2
CLO-3	**Demonstrate** the use of instruments and control techniques for measuring and regulating different forms of energy system.		P-3	5
CLO-4	**Contribute** actively as an individual and in a group to accomplish the tasks assigned.		A-3	9

Course Outline for Theory

Precision measurements terminologies principles of different measurement techniques; instruments for measurement of different types of energy including electrical, mechanical and chemical etc; systems for signal processing and signal transmission; modern instrumentation techniques; construction and working of different analog and digital meters, Measuring instruments and recording instruments, signal generators, Sensors, Input and output transducers; types of bridges for measurement of resistance, inductance, and capacitance; power and energy meters; PLC systems etc.

Modeling of electrical, mechanical and biological control systems. Open and closed-loop systems, Block diagrams. First & Second order systems. Step and impulse response. Performance criteria. Steady state error. Sensitivity, s-plane system stability. Frequency domain analysis, Bode plots, Nyquist criterion, gain and phase margins, Nichols charts. State-space method, state equations, flow graphs, stability, PI, PD, and PID controllers.

Lab Outline

To study and become familiar with Oscilloscope, Measurement of Self-Inductance by Three Ammeter Method, Measurement of Capacitance by Three Voltmeter Method, Wheatstone bridge, Kelvin bridge, Maxwell Bridge, Hay Bridge, Schering Bridge, Wien Bridge, LDR & RTD, Ultrasonic Sensor, Electronic Wattmeter & Energy Meter.
Modelling of physical systems, linear control system modelling, First and Second Order system response, computing Nyquist Criteria, root-locus and Bode plots. PI, PD and PID controllers.

Recommended Books
1. A.D. Helfrick and W.D. Copper, Modern Electronic Instrumentation and Measurement Techniques, Phi, 2002.
2. Robert B. Northrop, Introduction to Instrumentation and Measurements, Taylor, and Francis - Boca Raton, 2005.
3. David A. Bell, Electronic Instrumentation and Measurement, Oxford University Press, 2010.
4. Katsushiko, Ogata, Modern Control Engineering, Pearson,2010.
5. R. C. Dorf and R. H. Bishop, Modern Control Systems, Pearson, 2011

Course Content

8.26 Power Plant Technology

CODE & TITLE (ENT-312) **Power Plant Technology**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** basic concepts and working mechanisms of power plants.	C-2	1
CLO-2	**Apply** thermodynamic laws and basic governing equations of power plants.	C-3	2
CLO-3	**Determine** environmental impacts of exhaust and flue gases of power plants.	C-3	7
CLO-4	**Conduct** experiments to determine effects of operating parameters of power plants.	P-4	4
CLO-5	**Contribute** actively as an individual and in a group during practical work.	A-3	9

Course Outline

Steam Generators and Turbines: Boiler types and furnaces and their applications; boiler components, boiler operation and safety, water treatment. Impulse and reaction turbines; Pressure and Velocity Compounding, Turbine governing and controls. Steam Powerplants: Rankine Cycle, Superheat, Reheat; Regenerative Cycle, Open Type Feed Water Heaters (FWH), Closed Type FWHs with Drains Cascaded Backwards and Pumped Forward. Gas Turbine Powerplants: Gas turbine (Brayton) cycle, regeneration, intercooling. Combined Cycle Powerplants: Topping and bottoming cycles, combined cycle efficiency, Cogeneration of power and process heat, Back Pressure and Extraction Turbines. Diesel Engine Powerplant: General layout, Site selection criterion, performance characteristics & environmental impact consideration. Nuclear Power Plant: Nuclear fuels, nuclear reaction types, Components, reactor types, Site selection criterion. Safety and environmental considerations of power plant.

Lab Outline

To study and become familiar with working mechanics of various components of power plants like boilers furnaces, turbines, condensers etc. Apply energy and mass balance of power plants, Measurement of various performance parameters of power plants like combustion, efficiency, power requirements etc. Study piping system of power plants. Analysis of power plant cycles through experimental data

Recommended Books
1. El-Wakil, M.M., Power Plant Technology, McGraw-Hill, 2002. 2. Larry Drbal, Pat Boston, “Powerplant Engineering”, CBS Publishers. 3. Black, Veatch, “Power Plant Engineering”, Springer, 1996. 4. P.K. Nag, “Power Plant Engineering”, McGraw-Hill, 2002. 5. Thomas Elliott, Kao Chen, Robert Swanekamp, “Standard Handbook of Powerplant Engineering”, McGraw-Hill, 1997.

Course Content

8.27 Fuel Processing Technology

CODE & TITLE (ENT-313) **Fuel Processing Technology**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Breadth**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** fundamental concepts of fuels, and processing techniques.	C-2	1
CLO-2	**Solve** various problems of fuels, and processing techniques.	C-3	2
CLO-3	**Perform** experiments for characterization of fuels and their processing systems.	P-3	4
CLO-4	**Contribute** actively as an individual and in a group during practical work.	A-3	9

Course Outline

Introduction (Fuels): Classification of Fuels, conventional and non-conventional fuels, characterization of fuels in terms of calorific values, Octane and Cetane values, pour point, flash point etc. Wood: Composition, Combustion Characteristics of Wood, Carbonization of Wood – Wood Charcoal, Bagasse. Peat: Introduction, Types and Composition, Commercial Production of Peat, Combustion Characteristics of Peat, Low-Temperature Carbonization of Peat, Producer Gas from Peat. Coal: Origin of Coal, Classification, Coal Properties and Structure, Coal Structure, Coal Mining, Transportation of Coal, Coal Cleaning, The Use of Coal, Clean Coal Technology, Iron and Steel Production, Use of Coal in Cement Production, Liquid Fuels from Coal, coal processing. Crude Oil: Consumption of Oil, Oil Demand by Sectors, Exploration, Drilling, and Production, Crude Oil Benchmarking, Crude Oil Characterization, Crude Oil Refining. Oil processing techniques. Natural Gas: Formation of Natural Gas, Composition of Natural Gas, Combustion Properties of Natural Gas, Natural Gas Production; Extraction and Processing, Gas-Oil Separation, Oil and Condensate Removal, Dehydration, Glycol Dehydration (Glycol Injection), Oil Absorption Process, Liquefied Natural Gas (LNG) Liquefaction Process, Transportation and Storage of LNG, LNG Storage Facility.

Lab Outline

Perform characterization of fuels in terms of calorific values, Octane and Cetane values, pour point, flash point etc. Understand working mechanics of various components of fuel processing techniques. Measurement of various performance parameters of fuel processing systems like efficiency etc. Analysis of various fuel processing systems through experimental data.

Recommended Books	
1.	T.R. Ghosh and M.A. Prelas, "*Energy Resources and Systems Volume 1: Fundamentals and Non-Renewable Resources*", Springer Science plus Business Media B.V., 2009.
2.	W. Francis and M.C. Peters, "*Fuels and Fuel Technology*," 2nd edition, Pergamon Press, 1980.
3.	R.C. Gupta, "*Fuels, Furnaces, and Refractories*," PHI Learning Private Limited, 2016.
4.	S. Lee, J.G. Speight, and S.K. Loyalka, "*Handbook of Alternative Fuel Technologies*," 2nd edition, CRC Press, 2015.

Course Content

8.28 Power Electronics

CODE & TITLE		CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN	
(ENT-224) **Power Electronics**		(2+1) **32 Theory + 48 Lab**	**Breadth Elective - I**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the basics of power semiconductor devices and converters.		C-2	1
CLO-2	**Analyze** the performance and output characteristics of different types of converters.		C-4	2
CLO-3	**Conduct** lab experiments to determine the performance of power converters.		P-3	5
CLO-5	**Contribute** effectively as an individual and coordinate with team members to accomplish tasks.		A-3	9

Course Outline

Introduction a. Principles of power electronics b. Recent advancement in Power Electronics and its Application c. Converter circuit components and their effects d. Converter control aspects 2. Power Electronic Devices a. Power Diodes b. Freewheeling diodes c. The Silicon-Controlled Rectifier (SCR) d. The Diac and Triac e. Diodes with RC and RL, LC and RLC loads. f. Power Transistors g. The Unijunction Transistor (UJT) h. The Programmable Unijunction Transistor (PUT) i. Types of thyristers j. Triggering devices k. Construction l. Characteristics, operations, losses, ratings, m. Control and protection of thyristors 3. Power Converters Rectifiers a. Static switches b. Solid state relays c. Single phase uncontrolled rectifiers d. Single phase semi-controlled rectifiers e. Single phase Fully controlled rectifiers f. Three-phase uncontrolled rectifiers g. Three-phase semi controlled rectifiers h. Three-phase fully controlled rectifiers 4. Inverters a. Single-phase inverters b. Three-phase inverters 5. AC-AC Converters a. Single-phase-to-single-phase cycloconveters b. Matrix converters. c. AC voltage regulators 6. DC-DC converters a. Buck converter b. Boost converter c. Buck-boost converters d. Isolated converters e. Forward converters f. Flyback converters.

Lab Outline

Uncontrolled Rectifiers. TRIAC Characteristics SCR Characteristics. Single Phase Controlled rectifiers. 3 Phase Controlled rectifiers. Buck Converter (non-isolated DC-DC converter). First Quadrant Chopper (DC Motor Speed Control). AC Power Control Using TRIAC-DIAC Combination. PWM Inverter, Switch Mode Power Supplies.

Recommended Books
1. M. H. Rashid, Power Electronics: Circuits, Devices & Applications, Prentice Hall, 2013. 2. Daniel Hart, Power Electronics, McGraw-Hill, 2011. 3. Ned Mohan, William P. Robbins and Tore M. Undeland, Power Electronics:Converters, Applications and Design,John Wiley & Sons, 2003.

Course Content

8.29 Power Transmission and Distribution

COURSE CODE & TITLE		CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN	
(ELT-221) **Power Transmission and Distribution**		(2+1) **32 Theory + 48 Lab**	**Energy Engineering Technology Breadth**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** basic and advanced concepts in power transmission and distribution.		C-2	1
CLO-2	**Analyze** electrical models for transmission and distribution lines.		C-4	2
CLO-3	**Perform** experiments on transmission and distribution line models.		P-3	4
CLO-4	**Adopt** safety practices to become a responsible member of society.		A-4	6

Course Outline for Theory

Transmission Lines: Purpose of transmission, choice of frequency and voltage, parameters of overhead transmission lines, types and calculations of transmission lines. Ferranti, corona and skin effects transmission lines. Mechanical Design of Overhead Lines: Line supports, sag and tension calculations, effect of wind pressure and ice loading, conductor vibration and use of dampers. Insulators: Insulator material, types of insulators, voltage distribution over insulator string, string efficiency, methods of improving the string efficiency, testing of insulators. DC AND AC Distributors: Pointed and uniform AC and DC distributors, distributors fed at one and both ends, ring mains, stepped mains, unbalanced loading of three phase AC distributors. Underground Cables: Cable resistance, inductance and capacitance, methods of cable installation, voltage drop and power loss, types of cables used in industries, cable fault localization. STATIC SUBSTATION: Substation location and layout, classification of substations, bus bar arrangement, grounding of star neutral point.

Lab Outline

Power Systems Overview. Primary Parameters of Transmission Line. Steady State Analysis of Transmission Lines. Insulators for Overhead Transmission lines. Transient Analysis of Transmission Lines. Mechanical Design of Overhead Lines, Introduction to distribution system, power cables, grounding and earthing, Power factor.

Recommended Books

1. Turan Gonen, Electrical Power Transmission System Engineering --- Analysis & Design, John Wiely& Sons, 1988.
2. V. K. Mehta Rohit Mehta, Principles of Power System, S Chand & Co Ltd,
3. C L Wadhwa, Electrical Power System, New Age International, 2006.
4. S. Sivanagaraju and S. Satyanarayana, Electric Power Transmission and Distribution, Pearson, 2008.

Course Content

8.30 Energy Conversion and Storage

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(ENT-314) **Energy Conversion and Storage**	(2+1) **32 Theory + 48 Lab**	**Breadth Elective - II**

	After completion of this course, students will be able to:	Bloom's Taxonomy Level	PLO
CLO-1	**Comprehend** fundamental working mechanism of various energy conversion and storage technologies.	C-2	1
CLO-2	**Understand** concepts of energy storage integration in various energy distribution systems.	C-3	2
CLO-3	**Analyze** case studies and problems related to energy conversion and storage systems.	C-4	2
CLO-4	**Perform** experiments of various energy conversion and storage systems.	P-3	4
CLO-5	**Contribute** actively as an individual and in a group during practical work.	A-3	9

Course Outline

Energy Conversion: Fundamentals of energy conversion techniques, Conversion of mechanical energy, Conversion of thermal energy, Conversion of thermal energy. Electrochemical Energy Storage, Batteries: Introduction to battery storage including lead acid, lithium ion, flow, and emerging battery technologies. Comprehensive analysis of design considerations and application specific needs. Ultra-Capacitors: Introduction to ultra-capacitors including operation applications, and emerging technologies, Topics include the usage in mobile applications and close proximity to renewable energy sources. Mobile vs. Fixed Energy Storage: Advantages and disadvantages of mobile vs. Stationary energy storage. b. Vehicle to grid applications and opportunities to leverage existing and emergent technology to provide additional grid support functions. Mechanical Energy Storage: Fly wheel study of flywheel capacity, availability, efficiency, and self-discharge, Applications in transportation, uninterruptible power supply (UPS), pulse power, and bulk storage. c. Selection and design of flywheels for safety and availability in various applications. Thermal Storage: Introduction to thermal storage with an emphasis on residential and utility scale applications including molten salts, cold reservoirs, and phase change materials, applications in renewable energy particularly utility scale solar and geothermal power production.

Lab Outline
Understand working mechanics of various components of energy conversion and storage systems. Apply energy and mass balance of energy conversion and storage systems, Measurement of various performance parameters of energy conversion efficiency etc. Analysis of various energy conversion and storage systems through experimental data
Recommended Books
1. Archie W. Culp, Principle of Energy Conversion, 2nd Edition, McGraw Hills, 1991. 2. Ter-Gazarian, A.G., Energy Storage for Power Systems, 2nd Edition, IET Publications (ISBN: 978-1849192194), (2011) 3. Huggins, R.A., Energy Storage, Springer, (ISBN: ISBN 978-1441910240, (2010) 4. İbrahim Dincer, Marc A. Rosen, Thermal Energy Storage; Systems and Applications, Second Edition, John Wiley & Sons, New York, (2011) 5. Lucas B. Hyman, Sustainable Thermal Storage Systems: Planning, Design, and Operations, McGraw-Hill(2011) 6. Frank S. Barnes, Jonah G. Levine Large Energy Storage Systems Handbook (ISBN 9781138071964), (2017)

Course Content

8.31 Solar Energy Technology

CODE & TITLE (ENT-315) **Solar Energy Technology**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Depth Core – I**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the basic concepts of solar technologies.		C-2	1
CLO-2	**Analyze** different types of olars energy systems for energy production.		C-4	2
CLO-3	**Simulate** solar energy systems.		P-3	5
CLO-4	**Conduct** experiments for result observance and its conformance using an integrated approach.		P-4	4
CLO-5	**Contribute** affectively as an individual or in a team for preparing solar setups.		A-3	9

Outline for Theory

Sun earth relationships, solar radiation and its measurement, solar radiation climatology; thermal processes in solar and flat-plate collectors; concentrating collectors; applications of solar thermal energy; photoelectric effect in semiconductor p-n junctions, solar photovoltaic components and systems, design of photovoltaic systems for electrification and water pumping; applications of photovoltaic solar energy; storage systems for solar energy; recent advances in solar energy applications.

Outline for Lab

Experiments on solar radiations such as intensity and angle measurement, Solar cell/ modules / arrays system design and calculations of electrical and thermal parameters, Experiments on different types on solar collectors for thermal and photoelectric effect production and measurement.

Recommended Books

1. CHETAN SINGH SOLANKI, Solar Photovoltaics: Fundamentals, Technologies And Applications, PHI Learning, 2015.
2. Catherine Gregory, Solar Energy for Beginners: The Complete Guide to Solar Power Systems, Panels & Cells, CreateSpace Independent Publishing Platform, 2015.
3. Jan F. Kreider, Solar Energy Handbook, McGraw-Hill Companies, 1981.

Course Content

8.32 Energy Audit and Management

CODE & TITLE (ENT-321) **Energy Audit and Management**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Depth Core – II**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the techniques of energy audit and management.		C-2	1
CLO-2	**Apply** various standards for energy management systems.		C-3	2
CLO-3	**Use** tools of energy audit and management.		P-3	5
CLO-4	**Perform** energy audit of an industry or organization for sustainability.		P-5	7
CLO-5	**Contribute** actively as an individual and in a group to accomplish tasks assigned.		A-3	9

Outline for Theory

The students will learn about energy audit process, economic analysis and life cycle, energy use in various industrial sectors and buildings, energy efficiency potentials in industry and buildings, and barriers to energy efficiency, managing energy efficiency in industry and buildings, barriers to energy efficiency from a sociotechnical perspective of energy efficiency. They will learn to use their understanding of these concepts in estimating energy consumption and impact of building design on energy performance. Lighting techniques – Natural, Compact Fluorescent Lamps (CFL), Light Emitting Diodes (LED) lighting sources and fittings, Calculation and costing of proposed energy conservation measure, Depreciation cost, sinking fund method. Cost evaluation by Return on Investment (ROI) and pay back method, Risk Analysis, Case study, Energy audit and its benefits, Energy flow diagram, Preliminary and detailed energy audit, Methodology of preliminary energy audit and detailed energy audit (Pre audit, Audit and Post audit), ISO 50001, Energy audit report, Introduction to tools required for energy auditing, Tools for energy audit (Power Analyzer, Combustion analyzer, fuel efficiency monitor, thermometer contact infrared, pitot tube and manometer, water flowmeter, leak detector, tachometer and lux meter).

Outline for Lab
Measure electricity usage by several devices, calculate energy usage for selected area or object, Use of alternative means to conserve the energy, Tools for energy audit (Power Analyzer, Combustion analyzer, fuel efficiency monitor, thermometer contact infrared, pitot tube and manometer, water flowmeter, leak detector, tachometer and lux meter).
Recommended Books
1. Albert Thumann, Terry Niehus, and William J. Younger, Handbook of Energy Audits, River Publishers, 2012. 2. Ian M. Shapiro, Energy Audits and Improvements for Commercial Buildings, Wiley, 2016. 3. L. Ashok Kumar, and Gokul Ganesan, Energy Audit and Management, CRC Press, 2022.

Course Content

8.33 Environmental Impact Assessment

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(ENT-XYZ) **Environmental Impact Assessment**	(3+0) **48 Theory 0 Lab**	**Depth Elective**

	After completion of this course, students will be able to:	Bloom's Taxonomy Level	PLO
CLO-1	**Demonstrate** methods of conducting an environmental impact assessment for energy projects.	C-3	7
CLO-2	**Analyze** the quantitative and qualitative evaluation criteria using software.	C-4	5
CLO-3	**Practice** environmental standards in measurement and decision making.	C-3	11

Outline for Theory

Introduction, An overview of environmental impact assessment; selection of scientific, engineering, and socio-economic factors in environmental impact assessment. Identification of quantitative and qualitative environmental evaluation criteria; application of traditional and other techniques for assessing impacts of predicted changes in environment quality. Approaches for identifying, measuring, predicting, and mitigating environmental impacts; modeling techniques employed in environmental impact assessment. Environmental standards and environmental impact assessment process; and methodologies for incorporating environmental impact assessment into management decision making. Students will learn to prepare an environmental impact prediction and apply environmental impact assessment as a tool in management decision making. Case studies of environmental impact assessment for several types of engineering/ science project are employed.

Recommended Books

1. John Glasson, and Riki Therivel, Introduction To Environmental Impact Assessment (Natural and Built Environment Series), Routledge, 2019.
2. Betty Marriott, Environmental Impact Assessment: A Practical Guide, McGraw Hill, 1997.
3. Arjun Kumar A. Rathi, Handbook of Environmental Impact Assessment: Concepts and Practice, Cambridge Scholars Publishing, 2022.

Course Content

8.34 Wind Energy Technology

CODE & TITLE		CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN	
(ENT-413) **Wind Energy Technology**		(2+1) **32 Theory + 48 Lab**	**Depth Elective**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the basic concepts of wind energy technologies.		C-2	1
CLO-2	**Analyze** the wind system design for energy production.		C-4	3
CLO-3	**Operate** wind power systems for power production investigation.		P-3	4
CLO-4	**Conduct** experiments for performance evaluation of wind systems.		P-4	4
CLO-5	**Contribute** actively as an individual and in a group to accomplish tasks assigned.		A-3	9

Outline for Theory

Historical uses of wind, Horizontal and Vertical axis wind turbines, Innovative wind turbines, Wind farms, Wind Characteristics, Meteorology of wind, Weibull statistics model, Wind Measurements, Wind Turbine Power, Energy, Torque, Blade aerodynamics, Transmission and generator efficiencies, Energy production and capacity factor, Turbine shaft power and torque at fixed and variable speeds, Wind turbine mathematical models, Mechanical components of wind turbines - Rotor, Blade, The Hub, Drive train, Couplings, Gearbox, Brakes, Yaw system, Main frame and nacelle, Tower, Mechanical Aerodynamic and Electrical subsystem, Pitch subsystem, Power quality, Turbine modes of operation, Turbine control strategies, Grid Integration of offshore wind farms, HVAC, Economics and Environmental Aspects of Wind Systems.

Outline for Lab

Experiments on wind energy such as air flow and performance of different types of wind turbines. Designing different types of wind turbines and performance evaluation using different simulation tools.

Recommended Books
1. Nick Jenkins, Tony L. Burton, Ervin Bossanyi, David Sharpe, and Michael Graham, Wind Energy Handbook, Wiley, 2021. 2. Mark Fenell, Wind Power Technologies Explained Simply, 2014. 3. Colin Anderson, Wind Turbines: Theory and Practice, Cambridge University Press, 2020.

Course Content

8.35 Heating, Ventilation, and Air Conditioning Systems

CODE & TITLE (ENT-XYZ) **Heating, Ventilation, and Air Conditioning Systems**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Depth Elective**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** fundamentals of HVAC systems and their applications.	C-2	2
CLO-2	**Solve** the problems of various air conditioning systems.	C-3	2
CLO-3	**Design** HVAC systems for domestic and commercial applications.	C-5	3
CLO-4	**Conduct** experiments on various HVAC systems**.**	P-4	4
CLO-5	**Contribute** individually and in team work on assigned tasks.	A-3	9
Outline for Theory			
Fundamentals of refrigeration cycles: Vapour Compression cycle, Vapour Absorption cycle, Types of Refrigerants, Refrigeration components and controls, Psychrometry, Air Conditioning Systems; Air Conditioning Equipment, components and controls, Duct Systems, Fans and Air Distribution Systems, Indoor Air Quality, Heating and Cooling Load Calculations, Energy efficient buildings, Automotive air conditioning system, Maintenance and Repair of Domestic and Commercial Equipment: maintenance of a new installation-sample scheduling, Types of air compressors, Compressor efficiency and operation, Capacity assessment, Leakage test, Factors affecting the performance and efficiency, compressor repair and checking the efficiency, Pneumatics, pneumatic control, descaling of condenser, purging or removing air from system; Refrigeration and Air conditioning Tools: List of tools and their applications, safety precautions, Fans and blowers: Types, Performance evaluation, efficient system operation, Flow control strategies and energy conservation opportunities.			
Outline for Lab			
Maintenance experiments on HVAC Components, Performance evaluation of Fans and Blowers, Energy Consumption analysis of the HVAC System.			

Recommended Books
1. John Tomczyk, Eugene Silberstein, Bill Whitman, and Bill Johnson, Refrigeration and Air Conditioning Technology, Cengage Learning, 2016. 2. Haines, Roger W. Wilson, Lewis, HVAC Systems Design Handbook, McGraw Hill, 2009. 3. John W. Mitchell, Principles of Heating, Ventilation, and Air Conditioning in Buildings, Wiley, 2012.

Course Content

8.36 Hydropower Technology

CODE & TITLE (ENT-412) **Hydropower Technology**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Depth Elective**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Discuss** different types of hydropower systems.		C-2	1
CLO-2	**Illustrate** the performance parameters of hydro turbines.		C-3	2
CLO-3	**Analyze** the environmental impact of hydropower system.		C-4	7
CLO-4	**Analyze** performance and operation of hydropower systems.		P-4	4
CLO-5	**Contribute** actively as an individual and in a group to accomplish tasks assigned.		A-3	9

Outline for Theory

Components of a hydropower plant, factors affecting hydro plant capacity. Types of dams, spillways and waterways, Run of the river system design, hydraulic turbines including Francis, Kaplan, Pelton and Turgo, mechanical design, hydraulic design, prototype operation. Performance and testing of governers; valves; flow control and closure gates. Auxiliary systems including compressed air system, tunnel and penstock dewatering systems, oil handling systems. Environmental control, effects on stream flows, aquatic life and water quality. Turbine performance and efficiency, hydropower economics & maintenance considerations.

Outline for Lab

Perform calculations on hydraulic parameters for different turbine concepts and hydraulic transients. Turbine design and calculation of different parameters.

Recommended Books

1. Wagner, H.J. and M. Jyotirmay, Introduction to Hydro Energy Systems, Springer-Verlag Berlin Heidelberg, 2011.
2. Bryan Leyland, Small Hydroelectric Engineering Practice, CRC Press, 2014.
3. Paul Breeze, Hydropower, Academic Press, 2018.

Course Content

8.37 Smart Grid Technology

COURSE CODE & TITLE: (ENT-414) **Smart Grid Technology**	**CREDIT & CONTACT HOURS** (2 + 1) **32 Th + 48 Lab**	**KNOWLEDGE AREA/DOMAIN** **Depth Elective**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** technologies of smart grids.	C-2	1
CLO-2	**Analyze** intelligent electrical power system in smart grid technology.	C-4	4
CLO-3	**Practice** on smart grid tools and simulation for different parameters.	P-3	5
CLO-4	**Contribute** actively as an individual and in a group to accomplish tasks assigned.	A-3	9

Outline for Theory

Introduction to Smart Grid: Integrated networks, renewable energy sources and modeling, modern monitoring, phasor measurement units, intelligent power system networks and their dynamics. Demand Side Management: Communication technologies for smart grid, SCADA and WAMS. Energy Management and Dispatch Plans: The optimal power flow problem, load flows. demand response Intelligent Electrical Power. System Dynamics: Frequency and active power balance, identify control-room technologies for system-wide remote monitoring, protection, and risk management of smart grid cyber security.

Outline for Laboratory Experiments

Demonstration on smart grid trainer having simulation of main energy sources (wind, hydro, solar, and coal) and power supplies. Perform experiment using resistive, capacitive, and inductive loads, fed by AC or DC supply. Use of protected equipment which permits the application of domestic and industrial rated electric magnitudes as well as their instrumentation. Synchronization methods, power and instrumentation transformers, and the inner physical phenomena can be measured and studied as individual elements or as part of the whole power distribution system.

Recommended Books

1. Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley-IEEE Press, 2012.
2. Janaka B. Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, and Akihiko Yokoyama, Smart Grid: Technology and Applications, Wiley, 2012.
3. by Bernd M. Buchholz, and Zbigniew Styczynski, Smart Grids – Fundamentals and Technologies in Electricity Networks, Springer Vieweg, 2014.

Course Content

8.38 Energy Markets

CODE & TITLE (ENT-XYZ) **Energy Markets**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Depth Elective**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the structure of energy markets.		C-2	3
CLO-2	**Illustrate** regulation and mechanisms in energy markets.		C-3	11
CLO-3	**Analyze** various pricing parameters for energy markets.		C-4	12

Outline for Theory

This course focuses on the market structures that exist within the electric energy industry. The course will provide a background on basic economic theory that is necessary to understand operational objectives, pricing and incentives, market power, etc. History of the electric power industry, regulation, and deregulation. Dispatch optimization problems that exist in the electric industry, approaches to solving these problems, and the corresponding markets. Different pricing methods, non-convex markets, uplift payments, etc.

Recommended Books

1. Jean-Michel Glachant, Paul L. Joskow, and Michael G. Pollitt, Handbook on Electricity Markets, Edward Elgar Publishing, 2021.
2. Kirschen and Strbac, Fundamentals of Power System Economics, John Wiley and Sons, 2010.
3. Roy L. Nersesian, Energy Economics: Markets, History and Policy, Routledge, 2016.

Course Content

8.39 Biomass Energy Technology

CODE & TITLE (ENT-323) **Biomass Energy Technology**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Depth Elective – III**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Determine** feasibility of energy production and its sustainability.	C-3	7
CLO-2	**Evaluate** process of biomass conversion technologies, and design studies.	C-5	3
CLO-3	**Perform** operation of anaerobic digester, biomass gasifier, and gas characterization.	P-4	4
CLO-4	**Follow** the safety requirements for energy generation.	A-3	12

Outline for Theory

Introduction to Biomass Resources and Technologies, Routes of Biomass Conversion Processes and biofuels production technologies, Characteristics of Biomass Fuels, Fuel analyses, Sample preparation, Techniques for characterization and chemical analyses of solid, liquid and gas samples, Relevance of feed properties for anaerobic digestion and thermochemical processes. Biomass Feedstock preparation, Thermochemical Conversion, Pyrolysis: Torrefaction, Slow and Fast Pyrolysis, Charcoal Production. Gasification: Technical and operations of Fixed bed Gasifier, Fixed bed Gasifiers, Fluidized bed Gasifiers, Entrained Bed Gasifiers. Anaerobic-aerobic digestion; Kinetics and mechanism- High-rate digesters for industrial wastewater treatment. Design, installation, operation and management of fixed dome and floating drum biogas plants, Power generation from biogas plants; Purification of biogas for grid quality methane/natural gas, Digester effluent utilization strategies; Combined heat and power production from Biomass; Concept of CHP in energy production.

Outline for Lab
Biomass physiochemical characterization for biological, chemical, and thermal conversion. bulk density, angle of repose, moisture contents, volatile matter contents, ash contents, heating value analysis etc. Experiments on different types of biomass gasifiers and digesters for liquid and gaseous fuel production and analysis.
Recommended Books
Text and Reference books: 1. Prabir Basu , Biomass Gasification and Pyrolysis: practical design and theory. India. AP Elsevier. 2010 2. Azad, A., and M. Khan. Bioenergy Resources and Technologies. Academic Press, California, USA. 2021. 3. Li, Y., and S. K. Khanal. Bioenergy: Principles and Applications. John Wiley & Sons, New Jersey, USA. 2020. 4. Drapcho, C.M., N.P. Nhuan and T.H. Walker. Biofuels Engineering Process Technology. 2nd Ed. MC Graw-Hill, New York, USA. 2020.

Course Content

8.40 Solar Thermal Technology

CODE & TITLE (ENT-XYZ) **Solar Thermal Technology**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Depth Elective**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand f**undamentals of solar thermal energy technologies.	C-2	1
CLO-2	**Understand** different solar collectors for energy generation, and their applications.	C-3	2
CLO-3	**Analyze** integration of solar thermal systems with storage technologies for efficient utilization of solar energy.	P-3	5
CLO-4	**Conduct** experiments to assess performance of solar thermal energy systems.	P-4	4

Outline for Theory

Solar radiation measurements: Solar charts; pyrheliometer; pyranometer; pyrgeometer; net pyradiometer-sunshine recorder; Heat transfer in solar systems: Energy balance of Flat plate collector; Flat-plate collector performance: incidence angle modifier; thermal test data conversion; design of solar heating systems; passive solar energy systems; Case studies related to active and passive use of solar energy; Design of thermal systems: classification; and performance analysis of various concentrated collectors; Automatic tracking systems; Solar-assisted technologies (solar distillation still, solar cold storage plant; solar cooker; solar bakery system solar roaster etc.) solar process economics; cost of solar process systems; life cycle savings methods; Thermal energy storage: Solar thermal energy storage technologies; Sensible heat storage system; Latent heat storage system; Sorption and thermochemical heat storage system; Metal hydride based solar thermal energy storage reactor; Energy and Exergy Analyses; Numerical Modeling and Simulation; Thermal Management with Phase Change Materials; System operation and application.

Outline for Lab

Experiments on different types of solar concentrators for diverse applications. Solar cell/ modules / arrays system design and calculations of thermal parameters.

Recommended Books
1. Cabeza, L.F. Advances in Thermal Energy Storage Systems - Methods and Applications,2nd Ed. Woodhead Publishing Series in Energy Series, Cambridge, UK. 2020. 2. Dincer, I. and M.A. Rosen.. Thermal Energy Storage: Systems and Applications, 3rd Ed. John Wiley & Sons, New York, USA. 2021 3. Duffie, J.A., W.A. Beckman and B. Nathan.. Solar Engineering of Thermal Processes, Photovoltaics and Wind: Photovoltaics and Wind, 5th Ed. John Wiley and Sons, New York, USA. 2020 4. Goswami, D.Y., F. Kreith and J.F. Kreider. Principles of Solar Engineering, 3rd Ed. Taylor & Francis, India. 2015

Course Content

8.41 Solar Photovoltaic Technology

CODE & TITLE (ENT-XYZ) **Solar Photovoltaic Technology**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Depth Elective**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Demonstrate** the working principle and conversion mechanism of photovoltaic cells.		C-3	1
CLO-2	**Analyze** the photovoltaic system design and measure its performance.		C-4	3
CLO-3	**Operate** different types of photovoltaic systems.		P-3	4
CLO-5	**Contribute** affectively as an individual or in a team for preparing solar setups.		A-2	9
Outline for Theory				
Semiconductor properties: Fermi-Dirac distribution function and location of fermi-level in doped semiconductor; Dynamics and densities of electrons and holes; Carrier transport mechanism: Interaction of light with semiconductor; Bandgap-to-bandgap processes; Generation and recombination of electron-hole pairs; Minority carrier lifetime; Poisson's Equation; Current density and continuity equations; P-N junction: Characteristics under darkness and illumination; Solar cell parameters and equivalent circuit; Parameter affecting the solar cell performance, Study of thin film deposition techniques, Standard and improved silicon solar cell manufacturing technology; High-efficiency concepts based on crystalline silicon technology; Hetero and multi-junction solar cell; Measurement and monitoring: Solar PV system components; Solar charge controllers; Types; Characteristics; Solar inverters type and characteristics; Solar cables; Solar mounting system; Solar PV system types; Solar PV off grid; Hybrid and on grid systems; Solar photovoltaic applications; Solar system performance measurement and monitoring; Solar system operation and maintenance; Dy sensitized solar cells; Perovskite solar cells				

Outline for Lab
Hands-on laboratory sessions on how a solar cell works in practice. Optimization of Series Resistance, calculations for tracking / non-tracking systems, Batteries for PV systems, Planning Procedure, System capacity and Energy Demand. Selection and sizing of cables.
Recommended Books
1. Goswami, D.Y.Principles of Solar Engineering, 3rd Ed. CRC Press, USA. 2015 2. Rabindra, S. and Pamuru V. Solar PV power design, manufacturing and applications from sand to systems, 1st Ed. Academic Press Cambridge, Massachusetts, UK. . 2020 3. Smets, A., K. Jager, O. Isabella, R. van Swaij and M. Zeman. Solar Energy: The Physics and Engineering of Photovoltaic Conversion, Technologies and Systems, 1st Ed. UIT Cambridge, UK. 2016. 4. Kalogirou, S.A. Solar Energy Engineering: Processes and Systems. 1st Ed. British Library. USA. . 2009.

Course Content

8.42 Electrical Vehicle Technology

CODE & TITLE (ENT-XYZ) **Electric Vehicle Technology**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Depth Elective**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the basics of electric and hybrid electric vehicles.		C-2	1
CLO-2	**Evaluate** the use of different electrical and hybrid vehicles.		C-4	2
CLO-3	**Practice** on different configurations of electric vehicles and its components.		P-3	4
CLO-4	**Conduct** performance analysis and energy management strategies in electric vehicles.		P-4	4
Outline for Theory				
Introduction: Electric Vehicle, Components of Electric Vehicle, Comparison with Internal combustion Engine: Technology, Comparison with Internal combustion Engine, Benefits and Challenges, EV classification and their electrification levels; Motor Torque Calculations for Electric Vehicle: Calculating the Rolling Resistance, calculating the grade resistance, Calculating the Acceleration Force, Finding The Total Tractive Effort, Torque Required On The Drive Wheel; Electric Vehicle Architecture Design: Types of Electric Vehicle and components, Electrical protection and system requirement, Photovoltaic solar based EV design, Battery Electric vehicle (BEV), Hybrid electric vehicle (HEV), Plug-in hybrid vehicle (PHEV), Fuel cell electric vehicle (FCEV), Electrification Level of EV, Comparison of fuel vs Electric and solar power, Solar Power operated Electric vehicles; Electric Drive and controller: Types of Motors, Selection and sizing of Motor, RPM and Torque calculation of motor; Energy Storage Solutions (ESS): Cell Types (Lead Acid/Li/NiMH), Battery charging and discharging calculation, Cell Selection and sizing; Electric Vehicles charging station: Type of Charging station, Selection and Sizing of charging station, Components of charging station, Single line diagram of charging station; Pakistan and GLOBAL Scenario: Technology Scenario, Market Scenario, Policies and Regulations, Payback and commercial model.				
Outline for Lab				
Different configurations of electric vehicles and its components, hybrid vehicle configuration, performance analysis and Energy Management strategies in electric vehicles.				

Recommended Books
1. John Lowry, and James Larminie, Electric Vehicle Technology Explained, Wiley, 2012. 2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2021. 3. Tom Denton, Electric and Hybrid Vehicles, Routledge, 2020.

Course Content

8.43 Geothermal and Ocean Energy

CODE & TITLE (ENT-XYZ) **Geothermal and Ocean Energy**	**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Depth Elective**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** types of geothermal energy, and natural fields.	C-2	2
CLO-2	**Illustrate** geothermal power and heat generation turbines.	C-3	4
CLO-3	**Explain** ocean and tidal energy conversion systems.	C-2	2

Outline for Theory

Geothermal Energy (resources, heat and electricity applications)Geothermal Energy Nature of fields , Earth structure, Classification of Geothermal Resources , Introduction to geothermal steam electric plants, Liquid Dominated System: Flashed Steam System, Total Flow Concept, Geothermal exploration, Geothermal power and heat generation turbines. Geothermal environmental impacts, Geothermal well drilling, geothermal reservoir engineering, geothermal electric power plants.

Single flash steam power plants, geo-fluid gathering system, piping layout, flashing process, separation processes. Double flash power plants, dry-steam power plants, binary cycle power plants.

Ocean as a source of energy, types of ocean energy, wave energy, wave energy conversion systems.

Hinged contour wave energy converters, Pelamis wave power system, Energy from ocean currents, marine turbine. Tidal energy conversion system, seawater impoundment.

Outline for Lab

Experiments on solar radiation such as intensity and angle measurement. Solar cell/ modules / arrays system design and calculations of electrical and thermal parameters. Experiments on different types on solar collectors for thermal and photoelectric effect production and measurement.

Recommended Books

1. Ronald DiPippo , Geothermal Power Plants, Elsevier, 2008.

2. H. Gupta and S. Roy, Geothermal Energy - An Alternative Resource for the 21st Century, Elsevier, 2007.

3. Lynne Peppas, Ocean, Tidal, and Wave Energy: Power from the Sea, Crabtree Pub Co 2008.

Course Content

8.44 Project Part-I

COURSE CODE & TITLE (ELT-316) **Project Part-I**		**CREDIT & CONTACT HOURS** (0+3) **0 Theory + 144 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Electrical Engineering Technology Domain Project**	
After completion of this course, students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Identify** and apply background knowledge of engineering technology fundamentals to the proposed project idea and compare with earlier related projects.		C-3	1
CLO-2	**Analyze** the problem statement through research and literature review.		C-4	2
CLO-3	**Defend** the impact of proposed idea in societal and environmental contexts and demonstrate it is in line with sustainable development protocols.		C-5	10
CLO-4	**Develop** a wide range of technical skills by developing a prototype using the latest design tools, which has passed the design, implementation, testing and evaluation stages.		C-6	3
CLO-5	**Integrate** solution of Complex Engineering Technology Problems for improvement of society or the environment.		A-4	7
CLO-6	**Adopt** ethical values and avoid plagiarism in writing reports.		A-5	7
CLO-7	**Exhibit** effectiveness as an individual, and in a team environment.		A-4	8
CLO-8	**Improve** their communication skills through presentations, technical report writing, and making posters.		A-5	9
CLO-9	**Display** performance of hardware components tested which could be used for software development.		P-5	5

Course Content

8.45 Project Part-II

COURSE CODE & TITLE (ELT-324) **Project Part-II**		**CREDIT & CONTACT HOURS** (0+3) **0 Theory + 144 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Depth Elective – IV**
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Devise** an experimentally verified system which can solve Broadly Defined Engineering Technology Problems.	C-6	3
CLO-2	**Implement** proposed design using modern technology to solve Broadly Defined Engineering Technology Problem.	C-3	5
CLO-3	**Investigate** and analyze results obtained from the implemented design.	C-4	4
CLO-4	**Practice** ethical principles, avoid plagiarism, and follow engineering technology professional norms.	A-5	7
CLO-5	**Exhibit** effectiveness as an individual, and in a team environment.	A-4	8
CLO-6	**Improve** their communication skills through presentations, technical report writing, and making posters.	A-5	9
CLO-7	**Demonstrate** management skills as a team member or leader to manage the project.	A-4	10
CLO-8	**Revise** and improve conventional solutions by adapting modern technology.	P-6	11

9. Supervised Industrial Training (SIT)

9.1 Background

Supervised Industrial Training (SIT) refers to students supervised hands-on experience in an environment where engineering technology is practiced, familiarizing them with professional engineering technology work prior to graduation. The training curriculum consists of a minimum of 16 weeks of continuous industrial training, comprising of 8 hours per day, 5 working days per week. A Bachelor of Engineering Technology student must undergo a mandatory SIT during the 8th semester (16 weeks), or 7th and 8th semesters (16 weeks in 8th semester mandatory, and 16 weeks in 7th semester optional), after he/ she has passed all subjects up to, and including, the 6th semester.

SIT covers a range of activities, such as design implementation, production processes, laboratory experiments, on-site field works and maintenance. It also serves as a mechanism to integrate engineering technology practices and the curriculum to achieve Program Learning Outcomes (PLOs) that cover Engineering Technologists Graduate Attributes in line with the Sydney Accord. While SIT provides practical exposure to engineering technology processes and helps develop professional skills required for an Engineering Technologist, it also offers an opportunity to prospective employers to assess potential skills of a future employee.

9.2 Objectives

Through the SIT, students will:

a. Learn to apply engineering technology knowledge learned in classroom environment to real industrial situations.
b. Be provided exposure to professional practices in the industries.
c. Understand the role, responsibilities, and code of ethics that Engineering Technologists must uphold.
d. Develop awareness about general workplace behavior and build interpersonal skills.
e. Learn to maintain professional work records and reports.
f. Learn to write reports.
g. Have opportunities to network with probable future employers.

9.3 Responsibility of HEI: Placement in SIT Program

During 7th (Optional) and 8th semesters, Bachelor of Electrical Engineering Technology students will undergo continuous SIT of 16 (or 32) weeks. This training shall be arranged by HEIs in leading industries, and preferably should sign an MoU for the SIT. A designated Administrator or Coordinator of the HEI shall complete all necessary documentation, preferably 12 weeks prior to the commencement of the training, and issue Training Schedule for 16 (or 32) weeks, so that all stakeholders and students are aware and assured of undergoing SIT training in 7th (optional) and 8th semester according to a scheduled timeline.

9.4 Responsibilities of Students

a. Bachelor of Energy Engineering Technology students shall get enrolled for SIT during the 6th semester and before commencement of 7th semester.

b. Students shall have to undergo continuous training of 16 (or 32) credit hours. One week's training comprising of 8 hours daily, for 5 days (40 contact hours) will be counted as 1 credit hour. Accordingly, a 16-week semester will earn students 16 credit hours.
c. Total contact hours per semester are: 16 weeks per semester x 5 working days per week x 8 hours per day = 640 hours. If an HEI opts for SIT in 2 semesters (7^{th} and 8^{th}), these credit hours and contact hours shown in (b) and (c) above will be doubled.
d. Students will maintain a daily Logbook, signed by the SIT supervisor at site, Training Administrator appointed by the HEI, and the student.
e. Students must observe safety and security rules of the organization where they receive Training.
f. Students must wear specified working clothes during training.
g. Students must obey all rules and regulations of the organization.
h. Students must observe the work-timings of the training organization.
i. For genuine personal emergencies, students may be allowed 10 days leave during training period of 16 (or 32) weeks, subject to approval by the HEI's training Administrator or Coordinator.
j. Leave will be deducted from training hours, and the shortfall must be made up later.
k. Unsanctioned leaves shall be treated as "absent", and liable to disciplinary action.
l. Public holidays and leave should not be counted as working hours.

9.5 Training Progress Assessment and Review by HEI

Every HEI should appoint a focal person as SIT Administrator or Coordinator for each program who will monitor progress with random site visits, phone calls, or emails to the industrial organization's counter-part focal person. Progress reports will be maintained after coordination with training supervisor(s) as well as the students.

The purpose of monitoring of SIT by Training Administrator or Coordinator is:

a. To ensure the training organization is providing suitable and appropriate training to students.
b. To obtain feedback on students' performance and training progress through discussions with training supervisor(s).
c. To make courtesy visits and establish industrial relations between the HEI and the industries where students receive their SIT.
d. To discuss the possibility of students' job placement with the training organization.
e. To survey new industries as potential training placement locations in the future.

9.6 Changing Student Placement During SIT

a. Students are discouraged to change placement during the training period from one organization to another.
b. However, written permission may be granted by the HEI's training Administrator or Coordinator, if a new placement is available and confirmed in another organization, and the student does not suffer loss of training-hours due to this changeover.

c. After getting a written permission from the Training Administrator or Coordinator, a fresh approval from the HEI must be obtained for the new placement.

9.7 Daily Training Logbook

All training activities must be recorded daily in the Training Logbook [See Appendix F]. Students must get it signed daily by the Trainer.

The Training Logbook must reflect:

a. The student's learning experience during the industrial training
b. Detailed training records of supervised training, with evidence of participation of:
    - The student
    - On- the-job Trainer, and
    - HEI's training Administrator or Coordinator.
c. Professional practice in engineering technology profession, where incidence and evidence are properly documented.
d. Information that becomes a source of reference in preparing the Industrial Training Report [See Section 9.8].
e. The Logbook must be submitted along with the Industrial Training Report.

9.8 Industrial Training Report

An Industrial Training Report will be submitted upon completion of SIT. The Report must describe student's learning and development in technical knowledge, engineering technology practices, and professional skills acquired through practical experience. The Industrial Training Report should also reflect the student's ability in communicating skills. Students should seek advice from their on-the-job Trainer, to ensure that no confidential materials are included in the Report. The Report shall be submitted to the HEI's Training Administrator. The student may present a copy of the Report to a prospective employer. Any references made in preparation of the Report should be shown using standard referencing formats. Students should refer to the Industrial Training Report Template as provided [See Appendix G], and Section 9.9 Guidelines for Preparation of Industrial Training Report in preparing the Report.

9.9 Guidelines for Preparation of Industrial Training Report

Under the guidance of supervisors, students need to properly document their experience and learning during the SIT in form of an Industrial Training Report. A properly prepared Report can portray their practical experience precisely in an orderly manner. The Report must be prepared according to the format and the guidelines below:

9.9.1 Contents of Industrial Training Report

(a) Table of Contents

This section of the report shall consist of:

i. Headings
ii. Sub-headings
iii. Page numbers

Every appendix requires a title, and each page needs to be numbered accordingly.

(b) Background and Profile of the Training Organization

Brief and concise description of the organization in which the student is undertaking the SIT. The main items are:

i. Background and profile of the organization
ii. Vision and Mission Statements.
iii. Organogram.
iv. Title and position of the supervisor.
v. Any additional information (maximum three pages).

(c) Schedule of Duties Performed as a Trainee

This section briefly describes the time, duration and types of duties performed during the training. The description must follow the schedule of the training, i.e., in chronological order (for 16/32 weeks). The days when the student was not on duty must be properly recorded with cogent reasons.

(d) Experience During SIT

In this section, the student must fully describe the industrial training experience gained. Some suggested areas include:

i. Project (s) carried out.
ii. Supervisory work.
iii. Problems encountered.
iv. Problem solving process or approach.
v. Hands-on skills acquired.
vi. How productivity can be enhanced.
vii. Quality management system in place.
viii. Safety at work.

(e) Conclusions

Students provide an overall assessment in this section and arrive at conclusions regarding the SIT undergone. Contents may include:

i. Types of major work performed during SIT.
ii. Different modules of SIT.
iii. Comments whether SIT met the training objectives.
iv. Suggestions and recommendations for improvement of the SIT.

(f) References

A complete list of the references used in the Report must be included according to standard referencing format.

(g) Appendixes

Appendixes are additional information appended to support the main text of the Report. A copy of a letter of permission from the Training Organization must be attached as an appendix. Other suggested appendixes are:

i. Investigation and project report during SIT
ii. Technical drawings (that are not secret documents or proprietary etc.)
iii. Any other documents that are added to the Report.

(h) Figures and Tables

All figures, tables and similar content must be captioned, labeled, and mentioned in the main text of the Report.

(i) Notations, Symbols & Acronyms

If the report contains notations, symbols, and acronyms, these must be defined before they first appear in the main text. It is good practice to put list of notations, symbols, and acronyms on a separate page, appropriately titled, and placed after 'Tables of Contents' page.

Every appendix must have a title and be mentioned in the main text of the Report. All page numbers for appendixes must be in continuation of page numbers of the main Report.

9.9.2 Format of the Report

(a) General

i. Students are advised to start writing the SIT Report as soon as training commences to ensure a timely completion and submission.
ii. Do not include irrelevant materials, e.g., brochures from the organizations, or any publicity materials in the report.
iii. The Report must be typewritten on plain white A4 size paper, with 12-point Times New Roman font type and line spacing of 1.5.

(b) Abstract or Preface

The Report should start with an abstract or preface of maximum 2 pages, and should include:

i. Description of Organization providing SIT.
ii. Summary of the Report.
iii. Acknowledgements.

9.10 SIT Assessment

Assessment of the SIT should be based on the following parameter:

i.	On-the-Job Trainer Report	(20% marks)
ii.	HEI's Training/ Advisor Report through visits or survey	(10% marks)
iii.	Industrial Training Report	(50% marks)
iv.	Viva voce	(20% marks)

Please note that:

i. A minimum of 50% marks are required to pass the SIT.
ii. Students are advised to be diligent in writing their Report.
iii. The Report must be of good quality and portray in full the industrial experience and knowledge gained.
iv. The Report should not be in the form of short notes, or in a figurative form.
v. If the Report is not satisfactory, students shall rewrite the Report until it is deemed satisfactory.

9.11 Completion of Industrial Training

i. Upon completion of a 16 -- or 32 --week continuous SIT, a Confirmation Letter to this effect must be obtained from the training organization.

ii. The Confirmation Letter must be submitted to the HEI's Industrial Training Administrator or Coordinator for grading the SIT, along with:

- On-the-Job Trainer's Report
- Student Feedback Form, and
- Industrial Training Report.

APPENDIX A: Sydney Accord Knowledge and Attitude Profile

(Retrieved from www.ieagreements.org)

A Sydney Accord program provides:
SK1: A systematic, theory-based understanding of the natural sciences applicable to the sub-discipline and awareness of relevant social sciences.
SK2: Conceptually based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed consideration and use of models applicable to the sub-discipline.
SK3: A systematic, theory-based formulation of engineering fundamentals required in an accepted sub-discipline.
SK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for an accepted sub-discipline.
SK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations using the technologies of a practice area.
SK6: Knowledge of engineering technologies applicable in the sub-discipline.
SK7: Knowledge of the role of technology in society and identified issues in applying engineering technology, such as public safety and sustainable development (represented by the 17 UN-SDGs).
SK8: Engagement with the current technological literature of the discipline and awareness of the power of critical thinking.
SK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

APPENDIX B: Engineering Technologist Graduate Attribute Profile

(Retrieved from www.ieagreements.org)

As per Sydney Accord, Engineering Technologist Graduate is expected to have the following attributes:
Engineering Technology Knowledge: **SA1:** An ability to apply knowledge of mathematics, natural science, Engineering Technology fundamentals and Engineering Technology specialization to defined and applied Engineering Technology procedures, processes, systems, or methodologies.
Problem Analysis **SA2:** An ability to Identify, formulate, research literature and analyze Broadly Defined Engineering Technology problems reaching substantiated conclusions using analytical tools appropriate to the discipline or area of specialization.
Design/Development of Solutions **SA3:** An ability to design solutions for broadly- defined Engineering Technology problems and contribute to the design of systems, components, or processes to meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
Investigation **SA4:** An ability to conduct investigations of broadly defined problems; locate, search and select relevant data from codes, data bases and literature, design and conduct experiments to provide valid conclusions.
Modern Tool Usage **SA5:** An ability to Select and apply appropriate techniques, resources, and modern technology and IT tools, including prediction and modelling, to Broadly Defined Engineering Technology problems, with an understanding of the limitations.
The Engineering Technologist and Society **SA6:** An ability to demonstrate understanding of the societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to Engineering Technology practice and solutions to broadly defined Engineering Technology problems.
Environment and Sustainability **SA7:** An ability to understand and evaluate the sustainability and impact of Engineering Technology work in the solution of broadly defined Engineering Technology problems in societal and environmental contexts.
Ethics: **SA8:** Understand and commit to professional ethics and responsibilities and norms of Engineering Technology practice.

Individual and Teamwork **SA9:** An ability to Function effectively as an individual, and as a member or leader in diverse teams.
Communication **SA10:** An ability to communicate effectively on broadly defined Engineering Technology activities with the Engineering Technologist community and with society at large, by being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
Project Management **SA11:** An ability to demonstrate knowledge and understanding of Engineering Technology management principles and apply these to one's own work, as a member or leader in a team and to manage projects in multidisciplinary environments.
Lifelong Learning: **SA12:** An ability to recognize the need for and have the ability to engage in independent and life-long learning in specialist Engineering Technologies.

APPENDIX C: Engineering Technologist Professional Competence Profile

(Retrieved from www.ieagreements.org)

As per Sydney Accord, Engineering Technologist Graduate is expected to demonstrate the following competencies:
Comprehend and apply universal knowledge: **TC1:** Comprehend and apply the knowledge embodied in widely accepted and applied procedures, processes, systems, or methodologies.
Comprehend and apply local knowledge: **TC2:** Comprehend and apply the knowledge embodied procedures, processes, systems, or methodologies that is specific to the jurisdiction of practice.
Problem analysis: **TC3:** Identify, clarify, and analyze broadly defined problems using the support of computing and information technologies where applicable.
Design and development of solutions: **TC4:** Design or develop solutions to broadly defined problems considering a variety of perspectives.
Evaluation: **TC5:** Evaluate the outcomes and impacts of broadly defined activities.
Protection of society: **TC6:** Recognize the foreseeable economic, social, and environmental effects of broadly defined activities and seek to achieve sustainable outcomes (represented by the 17 UN-SDGs).
Legal, regulatory, and cultural: **TC7:** Meet all legal, regulatory, and cultural requirements and protect public health and safety during all activities.
Ethics: **TC8:** Conduct activities ethically
Manage engineering activities: **TC9:** Manage part or all of one or more broadly defined activities.
Communication and Collaboration: **TC10:** Communicate and collaborate using multiple media clearly and inclusively with a broad range of stakeholders during all activities.
Continuing Professional Development (CPD) and Lifelong learning:

TC11: Undertake CPD activities to maintain and extend competences and enhance the ability to adapt to emerging technologies and the ever-changing nature of work.
Judgement: **TC12:** Choose appropriate technologies to deal with broadly defined problems. Exercise sound judgement in the course of all broadly defined activities.
Responsibility for decisions: **TC13:** Be responsible for making decisions on part or all of one or more broadly defined activities.

APPENDIX D: Minutes of Preliminary Meeting of NCRC

1. The preliminary meeting of National Curriculum Review Committee (NCRC) was held on 07-09-2022 to 09-09-2022 at the University of Engineering & Technology, Taxila.

2. Welcome session was started with recitation of Holy Quran, and it was chaired by Honorable Engr. Imtiaz Hussain Gilani, Chairman NTC. In a welcome speech, objectives, and arrangements for NCRC were presented by the host Honorable Vice Chancellor UET, Taxila. Then, the Chairman NTC explicitly elaborated importance of curriculum development for B.Sc. engineering technology programs through more practical work engagement as well as keeping in view the futuristic approach, market demand and societal needs as per the scope of NTC and guidelines of Sydney Accord.

3. Mr. Hafiz Ghulam Muhammad represented NTC.

4. In the second session, the house was invited to nominate the Convener, Co-Convener, Secretary and Co-Secretary of the NCRC for smooth functioning. After discussion with members Prof. Dr. Fahad Azim was nominated as Convenor, and Dr. Syed Nasir Shah, Dr. Atiq Ur Rehman and Dr. Rabia Liaqat were nominated as Co-Convener, Secretary and Co-Secretary for the Committee, respectively.
   Following nominated members represented various HEIs from all over the Pakistan in NCRC for B.Sc. Energy Engineering Technology.

Sr.	NCRC Members	Role
1	Prof. Dr Fahad Azim Dean and Professor, Ziauddin University, Karachi	Convener
2	Dr. Syed Nasir Shah Assistant Professor, University of Engineering and Technology (UET), Taxila	Co-Convener
3	Dr. Atiq Ur Rehman Associate Professor, Balochistan University of Information Technology, Engineering and Management Sciences, Quetta	Secretary
4	Dr. Rabia Liaqat Associate Professor, National University of Sciences & Technology (NUST), Islamabad	Co-Secretary
5	Prof. Dr. Muzaffar Ali Professor, University of Engineering and Technology (UET), Taxila	Member
6	Engr. Dr. Shahid Atiq Assistant Professor, Khwaja Fareed University of Engineering & Information Technology (KFUEIT), Rahim Yar Khan	Member
7	Prof. Dr. Abdul Aziz Mazhar Ex-Dean, Institute of Space Technology, Islamabad	Member
8	Dr. Muhammad Saeed Assistant Professor, FAST-NUCES, Islamabad	Member
9	Dr Adnan Aslam Noon Chairman, International Islamic University, Islamabad (IIUI)	Member

Sr.	NCRC Members	Role
10	Dr. Haider Ali HoD, Shuhada-e-Army Public School University of Technology, Nowshera	Member
11	Dr. Amjad Ali Associate Professor, UET, Peshawar Jalozai Campus	Member
12	Dr Tariq Ullah Jan Associate Professor, UET, Peshawar	Member
13	Dr. Adnan Daud Khan Assci. Prof. / Director, UET, Peshawar	Member
14	Dr. Imdadullah Thaheem Assistant Professor, The Benazir Bhutto Shaheed University of Technology and Skills Development Khairpur Mirs	Member
15	Engr. Arif Hussain Coordinator, Karakoram International University (KIU), GB	Member
16	Mr. Hafiz Ghulam Muhammad NTC Representative, National Technology Council, Pakistan	NTC Representative

5. After taking charge of the nominated committee, convenor, Prof. Dr. Fahad Azim chaired the meeting and emphasized to ensure the reflection of Sydney Accord in curriculum and suggested modus operandi for sub-committees.

6. In continuation of above guidelines, Dr. Syed Nasir Shah, Dr. Atiq Ur Rehman and Dr. Rabia Liaqat assist formation of sub-committees.

7. Agreed upon objectives were categorized and assigned to Subcommittees, where honorable members reviewed, discussed, and submitted the following resolutions:

    - Develop an undergraduate curriculum of electrical engineering technology which is at par with international standards and in substantial conformity with the Sydney Accord.
    - Clearly define program education objectives (PEOs), course learning outcomes (CLOs) with taxonomy levels, and course contents aligned with program learning outcomes (PLOs).
    - Incorporate latest relevant reading materials/ references.
    - Ensure that course content that is uniform across other disciplines (HEC's Gen Ed requirements) is not duplicated.
    - Curriculum must be futuristic, and answer needs of society.

8. In next session, the house openly discussed the nomenclature of the discipline, preface, objectives of the programs, PLOs, methods of instruction and learning environment, assessment, and operational framework.

9. After long deliberation, the Committee proposed the curriculum framework, the duration of the program, number of semesters, number of weeks per semester, total number of credit hours, weightage of technology

domain and non-technology domain courses and weightage of theory and practical of undergraduate 4-years program in energy engineering technology.

10. Furthermore, list of courses (core and elective) and semester wise breakup of courses were also discussed thoroughly and finalized.

11. Admission/intake criteria were discussed and adopted same as defined in NTC Accreditation Manual.

12. Supervised industrial training (SIT) was discussed in detail. There was a consensus that SIT will be mandatory for 8th Semester.

13. Those HEI's that can provide only one semester of SIT (in 8th), shall offer optional courses instead of SIT in the 7th semester to cover credit hours and other requirements.

14. HEI's that are geared to provide SIT in two semesters can do this in 7th and 8th Semesters.

15. In line with the experience and expertise of NCRC members, list of courses of various domains were distributed among the Sub-Committees.

16. These Committees were assigned responsibility for reviewing course objectives, adding course learning outcomes, appropriate mapping with taxonomy and PLOs, updating list of contents, adding teaching-learning methods and assessment, and updating bibliography/ references/ suggested books.

17. The following Core Committee's, along with four Sub-Committees, were constituted:

Sr.	Sub-Committee	Name
1	Core committee	Prof. Dr. Fahad Azim (Convener)
		Dr. Syed Nasir Shah (Secretary)
2	Computing Humanities and Social Sciences	Dr. Muhammad Saeed
		Dr Tariq Ullah Jan
		Engr. Arif Hussain
3	Energy Engineering Technology Foundation Courses	Prof. Dr. Abdul Aziz Mazhar
		Dr. Amjad Ali
		Dr. Imdadullah Thaheem
		Dr. Haider Ali
4	Energy Engineering Technology Breadth Courses	Prof. Dr. Muzaffar Ali
		Dr. Atiq Ur Rehman
		Dr. Shahid Atiq
5	Energy Engineering Technology Depth Courses	Dr. Rabia Liaqat
		Dr. Adnan Daud Khan
		Dr Adnan Aslam Noon

18. After conclusion of the Preliminary Meeting, the Sub-Committees submitted the proposed course contents for theory and practicals, along with CLOs, list of recommended books, list of experiments and relevant information of each course.

19. The first draft was compiled by Dr. Syed Nasir Shah, Secretary NCRC, and distributed to Members for review.

20. Preliminary curriculum draft was submitted to NTC and sent to international reviewers.

APPENDIX E: Minutes of the Final Meeting of NCRC

1. The Final meeting of the NCRC was held on 09-11-2022 to 11-11-2022 at the University of Lahore, Lahore.

2. The inauguration session started with recitation of Holy Quran, and chaired by Honorable Rector of the University of Lahore, Lahore.

3. Engr. Imtiaz Hussain Gilani, Chairman NTC, joined the meeting online. He appreciated the efforts by Members and highlighted their valuable contribution for the national cause in setting standards for quality-education in energy engineering technology.

4. The Chair also extended his gratitude to the entire team and briefed the objectives and arrangements for the second NCRC.
5. The following members attended the meeting:

Sr.	NCRC Members	Role
1	Prof. Dr Fahad Azim Dean and Professor, Ziauddin University, Karachi	Convener
2	Dr. Syed Nasir Shah Assistant Professor, University of Engineering and Technology (UET), Taxila	Co-Convener
3	Dr. Atiq Ur Rehman Associate Professor, Balochistan University of Information Technology, Engineering and Management Sciences, Quetta	Secretary
4	Dr. Rabia Liaqat Associate Professor, National University of Sciences & Technology (NUST), Islamabad	Co-Secretary
5	Prof. Dr. Muzaffar Ali Professor, University of Engineering and Technology (UET), Taxila	Member
6	Engr. Dr. Shahid Atiq Assistant Professor, Khwaja Fareed University of Engineering & Information Technology (KFUEIT), Rahim Yar Khan	Member
7	Prof. Dr. Abdul Aziz Mazhar Ex-Dean, Institute of Space Technology, Islamabad	Member
8	Dr. Muhammad Saeed Assistant Professor, FAST-NUCES, Islamabad	Member
9	Dr. Haider Ali HoD, Shuhada-e-Army Public School University of Technology, Nowshera	Member
10	Dr. Amjad Ali Associate Professor, UET, Peshawar Jalozai Campus	Member
11	Dr. Adnan Daud Khan Assci. Prof. / Director, UET, Peshawar	Member

Sr.	NCRC Members	Role
12	Dr. Imdadullah Thaheem Assistant Professor, The Benazir Bhutto Shaheed University of Technology and Skills Development Khairpur Mirs	Member
13	Mr. Hafiz Ghulam Muhammad NTC Representative, National Technology Council, Pakistan	NTC Representative

6. After the introductory session, deliberations on the agenda of the second meeting formally commenced, which was headed by Convener Prof. Dr. Fahad Azim.

7. Honorable Members were informed that valuable feedback was received from the following international experts:

Sr#	Foreign Expert Name	Affiliation
1	Dr. Syed Faiz Ahmed	Aston University , UK
2	Dr. Hassan Tanveer	Kennesaw State University, Georgia/Virginia Tech, USA
3	Dr. Inam Nutkani	RMIT, Australia
4	Dr.Salah Ud-Din Khan	King Saud University, Riyadh, Kingdom of Saudi Arabia

8. In this regard, international experts appreciated the efforts done by NCRC to compose a balanced and standardized curriculum for Energy Engineering Technology.

9. Their proposed suggestions are incorporated in the curriculum and updating of courses contents.

10. Various issues were thoroughly deliberated upon by Members of NCRC in Sub-Committees, and honorable members submitted the following resolutions:

    - Agreed upon curriculum preface, mission, vision, preamble, rationale, scope, course scheme etc.
    - Finalized bench marking of Recommended Scheme of Studies, Engineering Technology domain and non-Engineering technology domain courses in comparison with framework and list of Electives as defined earlier.
    - Approved the Semester-wise break-up of courses, credit hours allocations and Breadth and Depth courses.
    - Recommended sample course profiles and contents.

12. The final draft was compiled by Secretary Dr. Syed Nasir Shah and Co-Secretary Dr. Rabia Liaqat.

13. After review by Members and with the approval of Convener Prof. Dr. Fahad Azim and Co-Convener Dr. Atiq Ur Rehman, it was submitted to NTC.

APPENDIX F: Supervised Industrial Training Logbook Sample Format

Student Details:
Name:
Roll Number:
Address:
Email:

Course of Study:
Year/Semester of Study:

Training Start Date:
Training End Date:

Training Organization Details:

Name of Organization:
Address:

Contact Person:
Contact Number:

On-the-job Trainer Name:
On-the-job Trainer Contact Number:

Daily Training Log

Please specify training information by descriptive statements, tables, sketches, figures, photographs, and so forth. Feel free to incorporate attachments wherever necessary.

Training Week: _____

Date	Time	Training Log

Declaration:

I, _____ Roll Number_____, do hereby declare that all information provided above is true and correct to the best of my knowledge.

_____
Student signature with date

_____ _____
Organization Supervisor signature with date HEI Coordinator signature & date

APPENDIX G: Supervised Industrial Training Report Sample Format

Sample table of contents for Supervised Industrial Training Report is provided so that students can develop an understanding of what is expected of them when making their submission. Students are encouraged to expand upon the content presented below. A declaration page validating the originality of work, duly signed by the student and the trainer, must be attached at the beginning of the Report.