Curriculum

for

Bachelor of Mechatronics 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	Integration of Data in Engineering Environment.
HEI	Higher Education Institution
SMEs	Small and Medium Enterprises
IEEE	Institute of Electrical and Electronics Engineers
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 instruction, 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 Appendix 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 Mechatronics 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 Appendix A through C].

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

Ideally an engineering program is designed with classroom to practical training ratio of 70:30 contact hours with emphasis on design aspects. Whereas for engineering technology programs, the ratio of contact hours is reversed to 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:

- 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).
- NCRC Members elect a Convenor, a co-Convenor, and a Secretary amongst themselves for the proceedings of NCRC, after mutual consultations.
- Preliminary Meeting of 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.
- A draft of program curriculum is prepared by NCRC at the end of the Preliminary Meeting and sent to relevant foreign experts for review and feedback.
- After foreign expert's review, a Final NCRC Meeting lasting up to three days is held to finalize the recommendations and prepare final curriculum document.

The entire cycle of curriculum development is completed in two months.

2.3 Historical Timeline of Meetings

Historical Timeline of meetings carried out in this context are enlisted below:

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

3. Curriculum Details

Bachelor of Mechatronics Engineering Technology Program			
Parameter	**HEC Framework**	**Framework - A (SIT in Semester 07 & 08)**	**Framework - B (SIT in Semester 08 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	39	45**
Engineering Technology Domain Courses	28	27	32**
Non-Engineering Technology Domain Courses	13	12	13**
Total Credit Hours	124 – 136	134	134
Engineering Technology Domain Credit Hours	85	101	99
Percentage of Engineering Technology Domain Courses	68.29%	69.23%	71.11%
Non-Engineering Technology Domain Credit Hours	39	33	35
Percentage of Non-Engineering Technology Domain Courses	31.70%	30.76 %	28.89 %
No. of Credit Hours per Semester	15 – 18	16 – 18	16 – 18
** Optional Courses may be included for Framework B (SIT in Semester 08 only)			
1 credit hour: (1) 1 contact hour per week for a minimum 15 weeks for theory: (2) 3 contact hours per week for a minimum of 15 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)**	**Contact Hours (Th+Lab)**	**Total Credit Hours**		**Number of Courses**	
				As per Scheme of Studies	**As per Framework A**	**As per Scheme of Studies**	**As per Framework A**
Computing	Computer Programming Fundamentals	1+1=2	1+3=4	7/9**	6	3/4**	3
	Computer Programming for AI	1+1=2	1+3=4				
	Computer Vision and Machine Learning	2+1=3	2+3=5				
	Computing Elective **	1+1=2	1+3=4				
Mechatronics Engineering Technology (Foundation)	Linear Circuit Analysis	2+1=3	2+3=4	17	20	8	10
		0+1=1	0+3 =4				
	Health, Safety and Environment	1+0=1	1+0 =1				
	Computer Aided Drawing	0+2=2	0+6=6				
		2+1=3	2+3=5				
	Materials and Manufacturing	2+1=3	2+3=5				
	Digital Logic Design	1+1=2	1+3=4				
	Mechanics Theory and Applications	2+1=2	2+3 =5				
Mechatronics Engineering Technology (Breadth)	Instrumentation and Measurements	1+1=3	1+3=4	15	24	5	6
	Thermo-Fluids	2+1=3	2+3=5				
	Linear Control Systems	2+1=3	2+3=5				
	Theory and Applications of Machine Elements	2+1=3	2+3=5				
	Actuating Systems	2+1=3	2+3 =5				
	Mechatronics Systems Design	1+1=2	1+3=4				

Mechatronics Engineering Technology (Depth)	Microcontroller and Embedded Systems	2+1=3	2+3=5	20 / 32**	14	7 /11**	5
	Thermal Systems and Heat Transfer	2+1=3	2+3=5				
	Introduction to Robotics	2+1=3	2+3=5				
	Industrial Automation	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				
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				
Training	Supervised Industrial Training-(Opt.)	0+16=16	0+16=48	16**	16**	0	0
	Supervised Industrial Training	0+16=16	0+16=48	16	16	0	0
Total Credit Hours and Courses (For Engineering Technology Domain Courses)		38+63=101	38+189=227	101	98 - 110	27/32**	27 - 31
** Optional Courses may be included for Framework B (SIT in Semester 08 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)	**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	Professional Ethics	3+0=3	3+0=3	3 / 5**	9	1 / 2**	3
		Elective-II (Optional)	2+0=2	2+0=2				
Management Sciences	Management Sciences	Elective-III (Optional)			6 / 6**	6	2 / 2**	3
		Elective-I	3+0=3	3+0=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	Elective-I	2+1=3	2+3=5	3	4	1	1
Total Credit Hours and Courses ** Optional Courses may be included for Framework B (SIT in Semester 08 only)					Cr. Hrs. **33/35****		Courses **12 /13****	

List of Elective Courses

Social Sciences Electives

- Sociology for Technologist
- Critical Thinking
- Organizational Behavior
- Professional Psychology
- Economics

Natural Sciences Electives

- Discrete Mathematics
- Numerical Analysis
- Complex Variables and Transforms
- Probability and statistics
- Vector Calculus
- Chemistry
- Biology

Management Sciences Electives

- Economics
- Project Management
- Entrepreneurship
- Leadership and Personal Grooming

Computing Electives

- Data Structures and Algorithms
- Internet of Things
- Big Data Analysis
- MATLAB and LabVIEW Programming
- Operating Systems
- Intelligent System
- Graphics and Visual Computing
- Computer Networks
- Virtual Systems and Services
- Web Technologies

Depth Electives

- Finite Element Analysis
- Optimization Techniques
- Computational Fluid Dynamics
- Joining of Materials
- Non-Destructive Testing of Components and Structures
- Energy and Power Technology
- Production Tooling and Automation
- Renewable and Alternative Energy Technologies
- Signal and Systems
- Electrical Machines
- Power Electronics
- Smart Grid Technology
- Automobile/Electric Vehicle Technology
- Sensor Networks
- Integrated Circuits Technology
- Telecommunication Systems Technology
- Digital Signal Processing
- Digital Image Processing
- Mobile Robotics
- Bio Robotics
- Aerial Robotics
- Underwater Robotics
- Robot Operating Systems
- Automotive Mechatronic Systems
- System Identification
- Modelling and Simulation
- Advanced Robotics
- Augmented and Virtual Reality
- Robot Grasping and Fixturing
- Digital Twin
- Condition Based Monitoring
- Fuzzy Control
- Digital Control
- Soft Robotics
- Human Robot Interaction

Note: Any relevant course can be included as an elective course with approval of the HEI's Statutory Bodies.

4. Admission Criteria

Criteria for admission in Bachelor of Mechatronics Engineering Technology program is defined in NTC's Accreditation Manual, 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 the Bachelor of Mechatronics Engineering Technology program spanning 4 years, spread over 8 semesters, and encompassing 134 credit hours is presented below:

SEMESTER-I				
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	**Contact Hrs. (Th+Lab)**
MTH-101	Islamic Studies / Social Ethics	Humanities and Social Sciences-I	3+0	3+0
MTH-102	Communication Skills	Humanities and Social Sciences-II	3+0	3+0
MTN-103	Calculus & Analytical Geometry	Natural Sciences-I	2+0	2+0
MTN-104	Applied Physics	Natural Sciences-II	2+1	2+3
MTT-111	Computer Programming Fundamentals	Computing-I	1+1	1+3
MTT-121	Linear Circuit Analysis	Mechatronics Engineering Technology Foundation-I	2+1	2+3
MTT-131	Workshop Practice	Mechatronics Engineering Technology Foundation-II	0+1	0+3
	Subtotal		**13+4**	**13+12 =25**
SEMESTER-II				
Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	**Contact Hrs. (Th+Lab)**
MTH-105	Pakistan Studies	Humanities and Social Sciences-III	3+0	3+0
MTH-106	Differential Equations	Natural Sciences-III	2+0	2+0
MTN-107	Natural Sciences Elective	Natural Sciences-IV	2+1	2+3
MTM-108	Management Sciences Elective-I	Management Sciences-I	3+0	3+0
MTT-132	Computer Aided Drawing	Mechatronics Engineering Technology Foundation-III	0+2	0+6
MTT-122	Electronics Devices and Circuits	Mechatronics Engineering Technology Foundation-IV	2+1	2+3
MTT-141	Health, Safety and Environment	Mechatronics Engineering Technology Foundation-V	1+0	1+0
	Subtotal		**13+4**	**13+12 =25**

SEMESTER-III				
Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	**Contact Hrs. (Th+Lab)**
MTH-201	Professional Ethics	Humanities and Social Sciences-IV	3+0	3+0
MTH-202	Technical Report Writing	Humanities and Social Sciences-V	3+0	3+0
MTN-203	Linear Algebra	Natural Sciences-V	2+0	2+0
MTT-231	Materials and Manufacturing	Mechatronics Engineering Technology Foundation-VI	2+1	2+3
MTT-211	Computer Programming for AI	Computing-II	1+1	1+3
MTT-221	Digital Logic Design	Mechatronics Engineering Technology Foundation-VII	1+1	1+3
MTT-232	Mechanics Theory and Applications	Mechatronics Engineering Technology Foundation-VIII	2+1	2+3
	Subtotal		**14+4**	**14+12 =26**
SEMESTER-IV				
Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	**Contact Hrs. (Th+Lab)**
MTT-222	Instrumentation and Measurements	Mechatronics Engineering Technology Breadth-I	1+1	1+3
MTT-233	Thermo-Fluids	Mechatronics Engineering Technology Breadth-II	2+1	2+3
MTT-241	Linear Control Systems	Mechatronics Engineering Technology Breadth-III	2+1	2+3
MTT-242	Actuating Systems	Mechatronics Engineering Technology Breadth-IV	2+1	2+3
MTT-234	Theory and Applications of Machine Elements	Mechatronics Engineering Technology Breadth-V	2+1	2+3
MTI-251	IDTE-I	Inter Disciplinary Technology Elective-I	1+1	1+3
	Subtotal		**10+6**	**10+18=28**
SEMESTER-V				

Course Codes	Course Title	Knowledge Area/Domain	Credit Hrs. (Th+Lab)	Contact Hrs. (Th+Lab)
MTT-341	Mechatronics Systems Design	Mechatronics Engineering Technology Depth-I	1+1	1+3
MTT-342	Microcontroller and Embedded Systems	Mechatronics Engineering Technology Depth-II	2+1	2+3
MTT-331	Thermal Systems and Heat Transfer	Mechatronics Engineering Technology Depth-III	2+1	2+3
MTT-311	Computer Vision and Machine Learning	Computing-III	2+1	2+3
MTT-3xx	Depth Elective-I	Mechatronics Engineering Technology Depth-IV	2+1	2+3
MTT-349	Project Part-I	Mechatronics Engineering Technology Domain Project	0+3	0+9
	Subtotal		**9+8**	**9+24 =33**
SEMESTER-VI				
Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	**Contact Hrs. (Th+Lab)**
MTM-301	Management Sciences Elective-II	Management Sciences-II	3+0	3+0
MTT-343	Introduction to Robotics	Mechatronics Engineering Technology Depth-V	2+1	2+3
MTT-344	Industrial Automation	Mechatronics Engineering Technology Depth-VI	2+1	2+3
MTT-3xx	Depth Elective-II	Mechatronics Engineering Technology Depth-VII	2+1	2+3
MTI-352	IDTE-II	Inter Disciplinary Technology Elective-II	1+1	1+3
MTT-349	Project Part-II	Mechatronics Engineering Technology Domain Project	0+3	0+9
	Subtotal		**10+7**	**10+21 =31**
SEMESTER-VII				
Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	**Contact Hrs. (Th+Lab)**

MTT-441	**Supervised Industrial Training**	**Mechatronics Engineering Technology Domain Industrial Training**	**16**	**40 (per Week)**
Framework B				
MTH-401/MTM-401	Social Sciences Elective/Management Sciences Elective-III	Humanities and Social Sciences-VI	2+0	2+0
		Management Sciences-III		
MTT-4xx	Depth Elective-III	Mechatronics Engineering Technology Depth-VIII	2+1	2+3
MTT-4xx	Depth Elective-IV	Mechatronics Engineering Technology Depth-IX	2+1	2+3
MTT-4xx	Depth Elective-V	Mechatronics Engineering Technology Depth-X	2+1	2+3
MTT-4xx	Depth Elective-VI	Mechatronics Engineering Technology Depth-XI	2+1	2+3
MTT-41x	Computing Elective	Computing-IV	1+1	1+3
	Subtotal		**11+5=16**	**11+15 =26**
SEMESTER-VIII				
MTT-442	**Supervised Industrial Training (Compulsory)**	**Mechatronics Engineering Technology Domain Industrial Training**	**16**	**40 (per Week)**
	Subtotal		**0+16= 16**	**0+40= 40**

6. Course Codes

Details pertinent to course code are presented below:

- Each course has a unique three letter prefix, followed by 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 will span over 4 years, with 2 semesters per year, Spring and Fall (with possible inclusion of Summer Semester).

Digits in course-code are defined in table below:

1st Digit	2nd Digit	3rd Digit
Denotes Year (1,2,3,4)	Denotes Streams 0- Non-Engineering 1- Computing 2- Electrical/Electronics 3- Mechanical 4- Mechatronics	Denotes Sequence (1, 2, 3…)

Letters in course-code prefix are defined below:

- First two letters pertain to the program (e.g., MT for Mechatronics)
- Third letter pertains to specifics of the course (e.g., T for technology, N for Natural Sciences etc.)

Sr.	Course Code Prefix	Description
1	MT**T**	Mechatronics Engineering Technology
3	MT**H**	Humanities and Social Sciences
6	MT**N**	Natural Sciences
8	MT**M**	Management Sciences
9	MT**I**	Inter Disciplinary Technology Elective

7. Elective Courses

The list of elective courses is presented below:

<table>
<tr><th>Knowledge Area</th><th>Credit Hrs.</th><th>Contact Hrs.</th><th>Framework</th></tr>
<tr><td>Depth Elective-I</td><td>2+1</td><td>2+3</td><td rowspan="2">A&B</td></tr>
<tr><td>Depth Elective-II</td><td>2+1</td><td>2+3</td></tr>
<tr><td>Depth Elective-III</td><td>2+1</td><td>2+3</td><td rowspan="5">B</td></tr>
<tr><td>Depth Elective-IV</td><td>2+1</td><td>2+3</td></tr>
<tr><td>Depth Elective-V</td><td>2+1</td><td>2+3</td></tr>
<tr><td>Depth Elective-VI</td><td>2+1</td><td>2+3</td></tr>
<tr><td>Computing Elective</td><td>1+1</td><td>1+3</td></tr>
<tr><td colspan="4">Depth Elective Courses</td></tr>
<tr><td colspan="2">Electrical/Electronic Stream</td><td colspan="2">Mechatronics Stream</td></tr>
<tr><td>Course Code</td><td>Knowledge Area</td><td>Course Code</td><td>Knowledge Area</td></tr>
<tr><td>MTT-32x</td><td>Depth Elective I and II</td><td>MTT-34x</td><td>Depth Elective I and II</td></tr>
<tr><td>MTT-42x</td><td>Depth Elective III to VI</td><td>MTT-44x</td><td>Depth Elective III to VI</td></tr>
<tr><td colspan="2">▪ Renewable and Alternative Energy Technologies
▪ Signal and Systems
▪ Electrical Machines
▪ Power Electronics
▪ Smart Grid Technology
▪ Automobile/Electric Vehicle Technology
▪ Sensor Networks
▪ Integrated Circuits Technology
▪ Telecommunication Systems Technology</td><td colspan="2" rowspan="3">▪ Digital Signal Processing
▪ Digital Image Processing
▪ Mobile Robotics
▪ Bio Robotics
▪ Aerial Robotics
▪ Underwater Robotics
▪ Robot Operating Systems
▪ Automotive Mechatronic Systems
▪ System Identification
▪ Modelling and Simulation
▪ Advanced Robotics
▪ Augmented and Virtual Reality
▪ Robot Grasping and Fixturing
▪ Digital Twin
▪ Condition Based Monitoring
▪ Fuzzy Control
▪ Digital Control
▪ Soft Robotics
▪ Human Robot Interaction</td></tr>
<tr><td colspan="2">Mechanical Stream</td></tr>
<tr><td>Course Code</td><td>Knowledge Area</td></tr>
<tr><td>MTT-33x</td><td>Depth Elective I and II</td></tr>
<tr><td>MTT-43x</td><td>Depth Elective III to VI</td><td colspan="2">▪ Energy and Power Technology
▪ Production Tooling and Automation
▪ Finite Element Analysis
▪ Optimization Techniques
▪ Computational Fluid Dynamics
▪ Joining of Materials
▪ Non-Destructive Testing of Components and Structures</td></tr>
<tr><td colspan="4">Computing Elective Courses</td></tr>
<tr><td colspan="2">▪ Data Structures and Algorithms
▪ Internet of Things
▪ Big Data Analysis
▪ MATLAB and LabVIEW Programming
▪ Operating Systems</td><td colspan="2">▪ Intelligent System
▪ Graphics and Visual Computing
▪ Computer Networks
▪ Virtual Systems and Services
▪ Web Technologies</td></tr>
<tr><td colspan="4">Note: Any relevant course can be included as an elective course with approval of the HEI's Statutory Bodies.</td></tr>
</table>

8. Course Contents

The 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.

Program Learning Objectives (PLO's), Course Learning Objectives (CLO's) and Bloom's Taxonomy Levels are expected learning outcomes and are aligned to standards set by the Sydney Accord and the IEA.

Course Content

8.1 Islamic Studies/Social Ethics

CODE & TITLE (MTH-101) **Islamic Studies**	**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Humanities and Social Sciences**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Recite** Holy Quran with correct pronunciation.	C-1	PLO-12
CLO-2	**Apply** understanding of basic concepts of teaching of Islam (faith, pillars, Dawit, preaching and Seerat).	C-3	PLO-12
CLO-3	**Produce** Compilation of the Holy Quran and Basic Concepts of Hadith.	A-2	PLO-12
CLO-4	**Present** Islam as a complete code of life.	A-3	PLO-10

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. A Guidebook for Muslims, by Syed. Abul Hasan Ali Nadvi. (Latest Edition)
2. An Introduction to Islam, by Dr. Muhammad Hameedullah. (Latest Edition)
3. What is Islam? by Maulana Manzoor Nomani. (Latest Edition)
4. Islamiat (A standard book for CSS), Prof. Dr. Arif Naseem. (Latest Edition)

Course Content

8.2 Communication Skills

CODE & TITLE (MTH-102) **Communication Skills**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Humanities and Social Sciences**	
After completion of this course students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Acknowledge** importance and basic concepts of communications.		A-1	PLO-10
CLO-2	**Identify** common errors usually made by learners of English as a second language.		A-2	PLO-10
CLO-3	**Communicate** effectively through technical writing and presentations, using basic- to-intermediate level English, and develop understanding of communication skills essentials.		A-3	PLO-10
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. Practical English Grammar, by A. J. Thomson and A. V. Martinet. Fourth edition. Oxford University Press. (Latest Edition) 2. Practical English Grammar Exercises 1, by A. J. Thomson and A. V. Martinet, Oxford University Press. (Latest Edition) 3. A Practical Guide to Business Writing: Writing in English for Non-Native Speakers, by Khaled Mohamed Al Maskari. Wiley. (Latest Edition) 4. Communication Skills for Engineers, by Sunita Marshal and C. Muralikrishna (Latest Edition) 5. The Essentials of Technical Communication, by Elizabeth Tebeaux and Sam Dragga, Oxford University Press. (Latest Edition) 6. College Writing Skills, by John Langan, 9th Edition (or Latest Edition) 7. Exploring the World of English, by Saadat Ali Shah, Ilmi Kitab Khana. (Latest Edition)				

Course Content

8.3 Calculus and Analytical Geometry

CODE & TITLE (MTN-103) **Calculus and Analytical Geometry**	**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Natural Sciences**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the ideas of rate of change, derivatives and it basic Applications.	C-2	PLO-1
CLO-2	**Apply** the techniques of integration for solving and analyzing problems in integral calculus.	C-3	PLO-2
CLO-3	**Describe** the vector calculus and analytical geometry in multiple dimensions for investigation of different engineering problems.	C-2	PLO-2

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", 11th edition (or Latest Edition), John Wiley, New York, 2016.
2. Essential Calculus by James Stewart, 2nd Edition (or Latest Edition)
3. G. B. Thomas, A. R. Finney, "Calculus", 14th edition (or Latest Edition), Pearson, USA, 2017.
4. S.M Yousaf, "Calculus and Analytic Geometry" (or Latest Edition).
5. Advanced Engineering Mathematics by Erwin Kreyszig, 10th Ed. (or Latest Edition) Willey 2014.

Course Content
8.4 Applied Physics

CODE & TITLE (MTN-104) **Applied Physics**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Natural Science**
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the basic principles of mechanics and motion, electricity and magnetism, and waves and optics.	C-2	1
CLO-2	**Apply** principles of physics to analyze and solve problems related to mechanical and electrical systems.	C-2	1
CLO-3	**Investigate** physical phenomena in the areas of mechanics, electricity, magnetism, waves, and optics.	P-2	3

Course Outline for Theory

Mechanics and Motion: Newton's Laws of Motion, Forces and Free-Body Diagrams, Kinematics of Linear and Circular Motion, Conservation of Energy and Momentum.
Electricity and Magnetism: Electric Charge and Coulomb's Law, Electric Fields and Potential, Circuits and Ohm's Law, Magnetic Fields and Forces, Electromagnetic Induction,
Waves and Optics: Wave Properties and Interference, Light and Electromagnetic Waves,
Applications in Mechatronics: Sensors and Transducers, Actuators and Motors, Feedback and Control Systems, Mechatronic Design and Integration.

Lab Outline

Investigating Forces and Free-Body Diagrams, Kinematics Analysis and Measurement, Experimenting with Collisions and Explosions, Measuring and Analyzing Electric Fields, Building and Testing Simple Electrical Circuits, Observing the Effects of Magnetic Fields on Moving Charges, Investigating Faraday's Law and Lenz's Law, Demonstrating Interference Patterns in Water and Sound Waves, Measuring and Analyzing Sound Waves in Different Media, Investigating Reflection, Refraction, and Polarization of Light.

Recommended Books

1. Fundamentals of Physics, Halliday, Resnick and Walker, 11th Edition 2018, Wiley.
2. Applied Physics, Dale Ewen, Neill Schurter, P. Gundersen, 11th Edition, Pearson Education,2016
3. Modern Physics New Edition by Gary N. Felder, Kenny M. Felde, 1st Edition 2022.

Course Content

8.5 Computer Programming Fundamentals

CODE & TITLE (MTT-111) **Computer programming Fundamentals**	**CREDIT & CONTACT HOURS** (1+1) **16 Theory + 16 Lab Sessions**	**KNOWLEDGE AREA/ DOMAIN** **Computing**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** and explain the fundamental concepts of computer programming.	C-3	1
CLO-2	**Analyze** and debug computer programs.	C-4	4
CLO-3	**Develop** programs to implement simple algorithms and to solve engineering problems.	C-5	5
CLO-4	**Demonstrate** programming skills on modern IDE's.	P-4	5

Course Outline

The nature of computers and code, what they can and cannot do, How computer hardware works, Chips, CPU, memory, disk Necessary jargon: bits, bytes, megabytes, gigabytes, How software works: what is a program, what is "running", How digital images work, Computer code: loops and logic, Big ideas: abstraction, logic, bugs, How structured data works, How the internet works: ip address, routing, ethernet, wi-fi, Computer security: viruses, trojans, and passwords, Analog vs. digital, Digital media, images, sounds, video, compression

Lab Outline

Overview of C programming language, data types and operators, Selection Control Structures (if, nested if-else, switch statement), Strings in C language, Pointers and Address Arithmetic, Structures in C-Language, User Defined Data Types and Unions, I/O Streams and File Handling, Repetition Control Structures (for, while, do-while loops), User defined Functions, One Dimensional Arrays, Multi-Dimensional Arrays, Classes and Inheritance, Recursion, Testing and Debugging, Program Efficiency computation.

Recommended Books

1. Introduction to Computers, Peter Norton's, 6th Ed., McGraw Hill
2. C++ How to Program, Paul Deitel and Harvey Deitel, 5th Ed., Pearson
3. Object Oriented Programming in C++, Robert LaFore, 4th Ed., Sams

Course Content

8.6 Linear Circuit Analysis

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/DOMAIN
(MTT-121) **Linear Circuit Analysis**	(2+1) **32 Theory + 16 Lab sessions**	**Mechatronics Engineering Technology**

	After completion of this course students will be able to:	**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Acquire** knowledge related to basic concepts, network laws, and theorems used to analyze linear circuits, and the behavior of energy-storing elements.	C-1	1
CLO-2	**Analyze** the linear circuits using network laws and theorems.	C-4	2
CLO-3	**Analyze** the different electrical parameters using ohms law, Kirchhoff current and voltage law, series, and parallel combination.	P-1	2
CLO-4	**Illustrate** different parameters using network laws and Theorems and a combination of RL, RC, and RLC circuits and measuring different parameters by using AC excitation.	P-2	2
CLO-5	**Report** the outcome of experiments/tasks.	A-1	8

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. Network 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.

Lab Outline

Ohm's law verification. RMS, average and peak values of periodic waveforms using the oscilloscope. Star and delta connections, relationship between line voltage and phase voltage/ line current and phase current in the three-phase star and delta connections. Verify circuit transformations using lab instruments.

Recommended Books
1. Electric Circuits Fundamentals, by Thomas L. Floyd and David M. Buchla, 9th Edition, Publisher: Pearson Education. 2. PSpice for Circuit Theory and Electronic Devices, by Paul Tobin, Publisher: Morgan and Claypool Publishers. 3. Basic Engineering Circuit Analysis, by J. David Irwin and R. Mark Nelms, 11th Edition, Publisher: Wiley. 4. Hughes Electrical & Electronic Technology, by Edward Hughes, 12th Edition, Publisher: Pearson Education. 5. Basic Engineering Circuit Analysis, by J. David Irwin and R. Mark Nelms, 12th Edition, Publisher: Wiley. 6. Introductory Circuit Analysis, by Robert L. Boylestad, 13th Edition, Publisher: Pearson Education.

Course Content
8.7 Workshop Practices

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-131) **Workshop Practices**	(0+1) **16 Lab Sessions + 0 lab**	**F Mechatronics Engineering Technology**

After completion of this course students will be able to:		Bloom's Taxonomy Level	PLO
CLO-1	**Explain** express and collect information regarding basic workshop operations.	C3	4
CLO-2	**Make** different model of the given components using different workshop processes.	P4	3
CLO-3	**Ability** to work and complete group projects.	A2	9

Lab Outline

Basic introduction to fundamentals of safety precautions in workshop practices, machines operations, and tools utilization. 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. Krar Steve F., Check Albert F., Machine Tools, 5th edition, McGraw-Hill, 1998.
2. Workshop Technology by Hajira Chohdry, 2nd edition, 2010.
3. Chapman W.A.J. "Workshop Technology (Part I, II & III). 2nd edition, 2018.
4. Fundamentals of Modern Manufacturing, 2nd Edition By M.P. Groover HT John Wiley & Sons, 7th edition, 2019.

Course Content

8.8 Pakistan Studies

CODE & TITLE (MTH-105) **Pakistan Studies**		**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab Sessions**	**KNOWLEDGE AREA/ DOMAIN** **Humanities and Social Sciences**	
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 state.		A-1	PLO-6
CLO-2	**Discuss** Pakistan Movement, political and constitutional history of Pakistan.		A-3	PLO-12
CLO-3	**Study** current issues of Pakistan, their causes and solution.		A-4	PLO-12

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. (Latest Edition)
2. Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, (Latest Edition)
3. Struggle for Pakistan by Mr. Ishtiaq Hussain Qureshi (Latest Edition)

Course Content

8.9 Differential Equations

CODE & TITLE (MTH-106) **Differential Equations**		**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 Lab Sessions**	**KNOWLEDGE AREA/ DOMAIN** **Natural Sciences**	
After completion of this course students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** knowledge about Differential equations, solutions of first and higher orders homogenous and non-homogenous differential equations by appropriate methods.		C-2	PLO-1
CLO-2	**Solve** linear differential equations using the Laplace transform technique and power series methods.		C-4	PLO-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 functions, 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. Advanced Engineering Mathematics by Erwin Kreyszig, Willey 2014. (or Latest Edition) 2. W. E. Boyce, R. C. DiPrima, "Elementary Differential Equations and Boundary Value Problems, 10th edition", John Wiley & Sons, Inc., 2012. (or Latest Edition) 3. D. G. Zill, M. R. Cullen, "Differential Equations with Boundary-Value Problems", 10th edition, Brooks/Cole, 2013. (or Latest Edition)				

Course Content
8.10 Natural Sciences Elective

CODE & TITLE (MTN-107) **From Natural Sciences Electives**	CREDIT & CONTACT HOURS (2+1) **32 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Natural Sciences**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of natural sciences elective courses defined in this curriculum. The HEI must ensure adequacy of academic and other resources for the course.		

Course Content
8.11 Management Sciences Elective-I

CODE & TITLE (MTM-108) **From Management Sciences Electives**	CREDIT & CONTACT HOURS (3+0) **48 Theory + 0 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Management Sciences**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of Management Sciences elective courses defined in this curriculum. The HEI must ensure adequacy of academic and other resources for the course.		

Course Content
8.12 Computer Aided Drawing

CODE & TITLE (MTT-132) **Computer Aided Drawing**		CREDIT & CONTACT HOURS (0+2) **0 Theory + 32 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Mechatronics Engineering Technology**
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Produce** orthographic projections, sectional views, and isometric views of different mechanical parts.	P-3	3
CLO-2	**Produce** assembly drawing for catalogues, manuals etc.	P-4	3
CLO-3	**Apply** basic concepts to develop construction (drawing) and Solid Modeling techniques	P-3	5
Lab Outline			
Introduction to drawing instruments, safety guidelines, layout, Lettering, Free-hand Sketching, Scaling and line types. Hands on practice of Geometric drawings, Drawing Sheet Planning, Orthographic Projections (1st and 3rd Angle). Practice projections and surface development. Practice and drawing of three views of different objects using			

orthographic projection. Creating drawings of engineering fasteners like rivets, cotter joints, threads, etc. Introduction to Geometric Dimensioning and Tolerances. Practice of various Assembly Drawings. 3-D Solid Figures using AutoCAD, Introduction to CREO, Learning Different Operations like Threading, Sweep, swept blend, Modeling, Assembling.
Recommended Books
1. Bhutt, N.D., Engineering Drawing, 50th edition, Charotar Publishing House, 2011. 2. Bertoline, Gary; Wiebe, Eric; Hartman, Nathan; Ross, William, Publisher: McGraw-Hill Education, Fundamentals of Graphics Communication 6th Edition, 2010 3. Minasi, Wempen, 2005, The Complete PC Upgrade and Maintenance Guide, 16th Edition, Sybex

Course Content

8.13 Electronic Devices and Circuits

CODE & TITLE (MTT-122) Electronic Devices and Circuits	CREDIT & CONTACT HOURS (2+1) 32 Theory + 16 Lab Sessions	KNOWLEDGE AREA/ DOMAIN Mechatronics Engineering Technology	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** and explain the basic construction, operation and characteristics of semiconductor devices and their circuits.	C-2	1
CLO-2	**Analyze** dc and ac response of small signal amplifier circuits using device models.	C-4	2
CLO-3	**Observe** the characteristics of semiconductor devices.	P-1	1
CLO-4	**Demonstrate** and analyze different electronic circuits to achieve desired outputs.	P-3	2
CLO-5	**Contribute** to perform the lab task in a group.	A-2	8

Course Outline for Theory

Study the formation of PN junction from semiconductor materials and diode 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.
Semiconductor: Doping: PN junction: Diode Characteristics curve: Resistances in Diode: Ideal & practical Models: Q-point analysis: Diode as Half wave & Full-wave Rectifier: Diode Switching Circuit: Clippers: Clampers: Bipolar Junction Transistor and its AC/DC configuration and characteristics: BJT as an inverter: Transistor types: Zener Diode: LED: Laser Diode: Photo & tunnel Diode: Field Effect Transistors: JFET: JFET current source: JFET Analog switch: JFET Biasing: MOSFET types & configuration

Lab Outline

Investigate the electrical characteristics of Diodes, BJT and FET. Biasing in BJT and FET. Design, implementation, and measurements of electronic circuits for different applications. Zener diode voltage regulators. Small signal amplifiers in BJT and FET. Amplifiers using lab equipment and computer simulation tools

Recommended Books

1. Electronic Devices and Circuit Theory, by Robert Boylestad and Louis Nashelsky, 11th Edition, Publisher: Pearson Education.
2. Electronic Devices, by Thomas L. Floyd, 10th Edition, Publisher: Pearson; 10th edition.
3. Electronics Principles, by Albert Malvino and David Bates, 8th Edition, Publisher: McGraw-Hill Education.
4. A Textbook of Electrical Technology, by B.L. Theraja and A.K. Theraja, Volume 1-5, Latest Edition, Publisher: S. Chand Publishing.

Course Content

8.14 Health, Safety and Environment

CODE & TITLE (MTT-141) **Health, Safety and Environment**	**CREDIT & CONTACT HOURS** (2+0) **32 Theory Sessions + 0 lab Sessions**	**KNOWLEDGE AREA/ DOMAIN** **Foundation**

After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** and describe the terms used in health safety and environment in engineering technology.	C-1	6
CLO-2	**Understand** and explain importance of health and safety in engineering technology and the responsibilities of a technologist to fulfill the corresponding requirements.	C-2	6
CLO-3	**Demonstrate** knowledge of Safety Health and Environment.	C-3	6
CLO-4	**Analyze** various types of hazards at work and living places.	C-4	2

Course Outline for Theory

1. Introduction of Health and Safety: Industrial Safety: introduction objectives of Safety, Importance of Safety in an industry, Industrial accidents, Effects of accidents, Types of accidents incidence of fire. Fire prevention and control.
2. Techniques of Safety Management: Principles of accident prevention, hazard analysis. Legal, humanitarian and economic reason for action. Safety inspection procedures. Safety training, First aid and emergency procedures.
3. Environment and Health: Introduction: importance of clean environment, Scale of Environmental Pollution. Environmental Act. Health and Safety Act.
4. Atmospheric Pollution: Types of Atmospheric pollution, Their Causes and Effects on Human Health, Available Technologies for Controlling Pollution.
5. Industrial Waste: Solid Waste, Industrial Effluents and Waste Gases, waste treatment plants.
6. Noise Pollution: Measurement of Noise level, Effect of excessive noise on human health. Remedial Measures.
7. ISO Standards for Safety and Health and Environment

Recommended Books

1. J. Ridley and J. Channing, Safety at Works, Routledge. 8th Edition, 2013.
2. K. G. Lockyer, Factory & Production Management, Pitman Publishing. 3rd Edition, 2001.

Course Content

8.15 Professional Ethics

CODE & TITLE (MTH-201) **Professional Ethics**		CREDIT & CONTACT HOURS (3+0) **48 Theory + 0 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Humanities And Social Sciences**	
After completion of this course students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Comprehend** the basic understanding of a profession, professional ethics, various moral and social issues, importance of values and professional ethics in personal life and professional career, and consequences of acting unethically in organization and society.		C-1	PLO-8
CLO-2	**Acquire** knowledge of various roles of engineering technologist in applying ethical principles at various professional levels.		A-3	PLO-6
CLO-3	**Resolve** the ethical dilemmas using common ethical values and identify possible actions to be taken in response.		A-5	PLO-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. Engineering Ethics Concepts & Cases by Charles E Harris, 5th Edition, Cengage 2014, (or Latest Edition)
2. Kenneth Blanchard, Professional Ethics, 4th Edition (or Latest Edition)
3. Ethics in Engineering 4th edition, by Mike W. Martin, Roland Schinzinger, McGraw-Hill, New York, 2005. (or Latest Edition)
4. The Seven Habits of Highly effective people by Stephan r. Covey (Latest Edition)
5. Engineering Ethics: Concepts and Cases, 4th edition, by Charles E. Harris, Michael S. Pritchard, Michael J. Rabins, Wadsworth, 2008 (or Latest Edition)
6. Professional Ethics: R. Subramanian, Oxford University Press, 2015. (or Latest Edition)
7. Ethics in Engineering Practice & Research, Caroline Whitbeck, 2e, Cambridge University Press 2015. (or Latest Edition)

Course Content

8.16 Technical Report Writing

CODE & TITLE (MTH-202) **Technical Report Writing**	**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab Sessions**	**KNOWLEDGE AREA/ DOMAIN** **Humanities and Social Sciences**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Discuss** the basic concepts in technical writing and use of standard word processing software along with referencing tool for report writing.	A-2	PLO-5
CLO-2	**Initiate** technically correct statements, assignments, final year project report, project proposal, short reports, research paper and business/ professional correspondence.	A-3	PLO-10

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. Technical Report Writing Today, by Daniel Riordan, 10th Edition (or Latest Edition)
2. Technical Writing and Professional Communication, Leslie Olsen and Thomas Huckin, 2nd Edition. (Or Latest Edition)
3. Communication for Engineering Students by J. W. Davies, (or Latest Edition)
4. Science Research Writing for Non-Native Speakers of English by Hilary Glassman-Deal, Imperial College Press. (Latest Edition)

Course Content

8.17 Linear Algebra

CODE & TITLE (MTN-203) **Linear Algebra**		**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 Lab Sessions**	**KNOWLEDGE AREA/ DOMAIN** **Natural Sciences**	
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	PLO-1
CLO-2	**Illustrate** the operations on matrices to solve systems of linear equations.		C-2	PLO-1
CLO-3	**Apply** linear transformations and applies matrix theory to model real-life situations.		C-3	PLO-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. Introductory Linear Algebra by Bernard Kolman (Latest Edition)
2. Advanced Engineering Mathematics by Erwin Kreyszig, 10th Ed. Willey 2014. (or Latest Edition)
3. D. C. Lay, S. R. Lay, J. J. McDonald, "Linear Algebra and Its Applications", 5th Edition, Pearson Education, 2015. (or Latest Edition)
4. Linear Algebra and its Applications by Gilbert Strang, 4th Edition, (or Latest Edition)

Course Content

8.18 Materials and Manufacturing

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-231) **Materials and Manufacturing**	(2+1) **32 Theory + 16 Lab Sessions**	**Mechatronics Engineering Technology**

	After completion of this course students will be able to:	**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** various types and properties of industrial materials.	C-1	1
CLO-2	**Determine** different traditional manufacturing operations used in industry.	C-3	1
CLO-3	**Define** different Non-traditional manufacturing operations used in industry.	C-1	12
CLO-4	**Apply** ethical principles while working in the laboratory and adopt necessary guidelines for student's health & safety.	A-3	8
CLO-5	**Perform** experiments/task/project related to materials and manufacturing laboratory independently.	P-2	9

Course Outline for Theory

Materials classification, material structure, atomic structure bonding, mechanical properties of materials (stress, strain, tensile strength, ductility, brittleness, and toughness etc.) Types of metal alloys, polymers and their classifications, ceramics and their classifications, composites, and their classifications.

Manufacturing processes and their classifications, casting fundamentals, Types of casting, Sand Casting, Mold design, Die casting, Problems in casting, Investment casting. Basic concept behind metal forming, Hot-working and cold working environment, Sheet metal forming, Extrusion, Wire drawing. Surface roughness, Grinding, Polishing, Painting. Injection Molding, Blow Molding and Rotational Molding. Electrical discharge machining (EDM), Laser beam machining (LBM), Water jet cutting (WJC), 3D Printing.

Lab Outline

Practicals are designed based on the contents covered in the theory. Following is the tentative list of Practicals. Institutions, depending on their needs and available resources can add or remove any practical.

To identify different materials (Metals, polymers and ceramics etc.,), To study the mechanical properties of different ferrous and non-ferrous materials, to prepare mold and core assembly for sand casting, produce circular flange, having four holes, using sand casting, to make a rectangular box using aluminium metal sheet with the help of shearing and bending machines. Apply different finishing operations such as grinding, painting on plate with holes. Understanding blow moulding machine operation. Manufacturing of hollow plastic parts using blow moulding.

Recommended Books
1. Material Science and Engineering an Introduction: By Willium D. Callister, Jr. 10th edition, 2018. 2. Engineering Materials: Research, Applications and Advance. By G.K. Gupta, 1st edition, 2014. 3. Fundamentals of Modern Manufacturing, 7th Edition, 2019, By M.P. Groover HT John Wiley & Sons

Course Content

8.19 Computer Programming for AI

CODE & TITLE (MTT-211) Computer Programming for AI	CREDIT & CONTACT HOURS (1+1) 16 Theory + 16 Lab Sessions	KNOWLEDGE AREA/ DOMAIN Computing	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Comprehend** the fundamental constructs of programming language for data analysis and representation.	C-2	1
CLO-2	**Understand** and apply the Object-oriented concepts in the programming language.	C-2	2
CLO-3	**Solve** and analyze programming and data analysis problems using standard libraries and/or toolboxes of the programming language.	C-4	4
CLO-4	**Demonstrate** the ability to implement AI algorithms using modern IDE's.	P-4	5

Course Outline for Theory

This course explores the concepts and algorithms at the foundation of modern artificial intelligence, diving into the ideas that give rise to technologies like game-playing engines, handwriting recognition, and machine translation. Through hands-on projects, students gain exposure to the theory and hands-on advanced programming in Python language with focus on advanced AI libraries for data visualization, data processing, computer vision and machine learning. 1By course's end, students emerge with experience in libraries for machine learning as well as knowledge of artificial intelligence principles that enable them to design intelligent systems of their own. Students will also be able to complete Google Ai certification after taking this course.

Lab Outline

Python Installation: Anaconda, Jupiter, PyCharm, Getting Started with Python, Programming Essentials: Variables, Data types, Conditions, Boolean, Loops, Strings, Lists, Tuples, Dictionaries, Defining and calling a Function, Classes and Inheritance, Implementation of search algorithms, Pandas, Matplot lib and Numpy, Scikit Learn Library, Creating Features, K-Means, Principal Component Analysis (PCA), Two Layered Neural Network Implementation

Recommended Books

1. Starting out with Python, Tony Gaddis, 5th Ed., Pearson
2. Python for Data Analysis: Data Wrangling with Pandas, Numpy, and Jupyter, Wes Mc Kinney, 2nd Ed., O'Reilly Media
3. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 4th Ed., Pearson

Course Content
8.20 Digital Logic Design

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-221) **Digital Logic Design**	(1+1) **16 Theory + 16 Lab Sessions**	**Mechatronics Engineering Technology**

	After completion of this course students will be able to:	**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** fundamental concepts used in the design of digital systems.	C-2	1
CLO-2	**Analyze** the working of combinational and sequential logic circuits using digital logic principles and Boolean algebra.	C-4	2
CLO-3	**Apply** principles of digital systems to design solutions for Broadly Defined Problems.	C-3	3
CLO-4	**Execute** small-scale digital circuits using Boolean algebra and K-maps for sustainable solutions.	P-4	7
CLO-5	**Carryout** experiments, using contemporary tools, under the supervision of instructors.	P-3	5

Course Outline for Theory

Number Systems: Truth Functions: Binary connectives: Evaluation of truth functions: Many statement compounds: Physical realizations: Sufficient sets of connectives: Digital computer examples: Boolean Algebra: Switching Devices: Minimization of Boolean functions: Tabular Minimizations. Cubical representation of Boolean functional: Determination of prime implicants: Selection of an optimum set of prime implicants: Design of NAND and NOR networks and properties of combinational networks: Switching expressions for NAND and NOR networks: Comparator: decoders: encoders: multiplexers and demultiplexers. Transient response of combination networks: Introduction to Sequential Networks: Latches: Sequential networks in fundamental mode: Introduction to the synthesis of sequential networks: Minimization of the number of states: Clocked networks. Flip-flops (RS: JK: D: T: master/slave): Counters.

Lab Outline

To study basic logic gates and their functions. To design a half-adder circuit. To design a full adder circuit. To design and implement a 4-bit adder using logic gate ICs. To design and implement a 4-bit subtractor using logic gate ICs. To analyze the operation of BCD to 7-segment decoder. To design a synchronous and asynchronous counter using J K flip flops. To design combinational circuits using multiplexer and demultiplexer. To analyze and study the operations of RS and Clocked RS Flip-Flop and D Flip-Flop 10. To analyze and study the operations of JK and Master-Slave JK Flip-Flop and T Flip-Flop. To design and implement 4-bit counters.

Recommended Books

1. Logic and Computer Design Fundamentals by Morris Mano and Charles R. Kime, 5th Edition.
2. Digital Fundamentals by Thomas Floyd, 11th Edition, Pearson.
3. "Digital Systems: Principles and Applications" by Ronald J. Tocci and Neal S. Widmer, 11th Edition, Pearson Education.

4. Digital Electronics: Principles and Applications by Roger Tokheim, 8th Edition, McGraw Hill.

Course Content

8.21 Mechanics Theory and Applications

CODE & TITLE (MTT-232) Mechanics Theory and Applications		CREDIT & CONTACT HOURS (2+1) 32 Theory + 16 Lab Sessions	KNOWLEDGE AREA/ DOMAIN Mechatronics Engineering Technology
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Apply** the concepts of mechanics to solve problems of friction, Kinematics and Kinetics of particles.	C-3	2
CLO-2	**Describe** mechanical behavior of materials under tensile, compressive, torsional and combined loadings, and Factor of safety.	C-1	1
CLO-3	**Work** on experiments/task/project related to applied mechanics laboratory independently.	P-2	9
CLO-4	**Attempt** participation in group discussion while practicing professional ethics.	A-2	8

Course Outline for Theory

Free body diagram, two force and three force members, plane trusses, method of joints, method of sections, frames and machine analysis, forces in beams and cables, friction, types of friction, dry friction, application of friction. Force, mass, acceleration, equation of motion. Work and Energy relationship. Mechanical Behavior of Ductile and Brittle materials, Recognize Failure due to axial loading in bars, columns etc, Determine strength, resilience, toughness and fracture under tensile and compressive loadings. Factor of safety calculations for different applications.

Lab Outline

Determination of Coefficient of Friction for various materials, Determination of Moment of Inertia of Fly Wheel. Determination of the Efficiency, velocity ratio, mechanical advantage of various systems such as screw jack worm and worm wheel, Pulleys and Tie and Jib crane. Determination of Linear and Angular speed. Determination of centrifugal force. Measurement of Angular Momentum.

Recommended Books

1. Mechanics of materials – R. C. Hibbeler, 11th edition, 2022.
2. Mechanics of Materials – Ferdinand Beer and E. Johnston and John DeWolf and David Mazurek, 7th edition, 2014.
3. Meriam, J.L. And Kraige, L.G., Engineering Mechanics: Dynamics (Vol. 2). 2012, John Wiley & Sons.
4. RC Hibbeler. Engineering Mechanics (Dynamics), 13th Ed. 2012, Prentice Hall.

Course Content

8.22 Instrumentation and Measurements

CODE & TITLE (MTT-222) **Instrumentation and Measurements**	**CREDIT & CONTACT HOURS** (1+1) **16 Theory + 16 Lab Sessions**	**KNOWLEDGE AREA/ DOMAIN** **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the theory of analogue DC and AC measuring instruments and associated errors.	C-2	2
CLO-2	**Analyze** the design of instruments and measurement of parameters using instruments.	C-4	3
CLO-3	**Demonstrate** the use of sensors, transducers, and electronic measuring instruments to mismatch losses.	P-3	5

Course Outline for Theory

Introduction: Principles and elements of measurement, instrument types, smart and non-smart instruments, static and dynamic characteristics of instruments, Necessity for calibration, Errors during the measurement process, systematic and random errors. DC/AC Indicating Meters: The d'Arsonval movement, galvanometer, DC ammeters, voltmeters and resistance measurements. DC meter calibration. Half wave and full wave rectifier meters. Single phase wattmeter and energy measurement meters. Instrument transformers (CT and PT). Electronics/Digital Meters: Sampling, Quantization, Data Acquisition, A/D conversion. Analog Electronic Meters: Transistor voltmeter circuits and operational amplifier voltmeter circuits, AC electronic voltmeters and current and resistance measurement. Digital Multimeters: Digital voltmeter, ohm meters and current meter.AC and DC Bridges: Resistance, capacitance and inductance bridges, The Wagner ground and commercial RLC bridges. Transducers and Sensors: Temperature transducers, Pressure transducers, Resistance and inductance transducers, Linear variable differential transformer (LVDT), Capacitive, photoconductive, and piezo-electric transducers, thermos-electric transducers. Basic principle of different sensor technologies.

Lab Outline

To study and understand the parameters of an 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.

Recommended Books

1. Modern Electronic Instrumentation and Measurement Techniques by Albert D. Helfrick and William David Cooper, 1st Edition, Pearson, 2019.
2. Measurement and Instrumentation Principles by Alan S. Morris and Reza Langari, 4th Edition, Elsevier, 2019.
3. Introduction to Instrumentation and Measurements by Robert B. Northrop, 4th Edition, CRC Press, 2018.
4. Electronic Instrumentation and Measurements by David A. Bell, 3rd Edition, Oxford University Press, 2019.
5. Electronic Instrumentation by H.S. Kalsi, 4th Edition, McGraw Hill Education, 2019.

Course Content
8.23 Thermo-Fluids

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-233) **Thermo-Fluids**	(2+1) **32 Theory + 16 Lab Sessions**	**Mechatronics Engineering Technology**

	After completion of this course students will be able to:	**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Solve** problems related to vapor and gas, positive displacement and roto-dynamic machines.	C-3	2
CLO-2	**Investigate** experimentally performance of various thermodynamic systems and applications.	P-2	4
CLO-3	**Explain** the fundamental properties of fluids, including viscosity, Newtonian and non-Newtonian rheology and classification of fluid flows.	C-2	2
CLO-4	**Demonstrate** teamwork and effectively communicate the experimental results.	A-3	9

Course Outline for Theory

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, Introduction to Pressure, pressure measurement gauges, Buoyancy and stability of submerged and floating bodies, Types of flow, flow rate and mean velocity, equation of continuity, steady and unsteady flow, fluid dynamics, properties and types of fluids, Bernoulli's theorem, energy equations and their applications, Flow through pipes and channels, losses in pipes, Piping standards

Lab Outline

Labs will be conducted on topics covered in theory such as Thermodynamic properties, Laws of Thermodynamics, Energy and work, Closed and Open systems, Thermodynamics cycles and Fuel and Combustion. Study of Hydraulic Bench. Determine the co-efficient of Venturi meter & discuss its application. To calibrate the given rectangular notch and discuss its application. To calibrate a triangular notch and discuss its application. To find the co-efficient of discharge. To calibrate the given pressure gauge & discuss its application. To study the impact of jets on vanes. To study the performance characteristics of centrifugal pump. To study the performance characteristics of Francis turbine.

Recommended Books
1. T. D. Eastop & A. McConkey (1994), Applied Thermodynamics for Engineering Technologist 5th edition Longman Education, 2. Y. A. Cengel and M. A. Boles, (2018), Thermodynamics, An Engineering Approach, 9th edition, McGraw-Hill 3. K R Arora, (2005), Fluid Mechanics and Hydraulic Machinery, 9th edition, Standard Publishers 4. E. John Finnemore, Joseph B. Franzini, (2002), Fluid Mechanics with Engineering Application 10th edition, McGraw-Hill

Course Content

8.24 Linear Control Systems

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-241) **Linear Control Systems**	(2+1) **32 Theory + 16 Lab Sessions**	**Mechatronics Engineering Technology**

	After completion of this course students will be able to:	**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** control systems in terms of types and applications, performance analysis of open loop and closed loop systems, and concept of stability.	C-1	2
CLO-2	**Illustrate** and develop a mathematical model of electrical and mechanical systems. Also, understand the block diagram representation and signal flow graph techniques.	C-3	3
CLO-3	**Analyze** the stability of Linear Time Invariant systems using stability tools. E.g., Routh Hurwitz Criteria, Bode etc.	C-4	4
CLO-4	**Analyze** industrial applications of control systems, having servo mechanism, and design a PID controller.	C-4	5
CLO-5	**Demonstrate** the concept of a control system using the MATLAB/control trainer.	P-2	4
CLO-6	**Trace** the problems associated with sensors, transmitter and actuator by Servomotor control using PID controller.	P-3	5

Course Outline for Theory

Introduction to control systems, open and close loop control systems. Principle of feedback systems. Modeling of electrical and mechanical control systems, time and frequency domain analysis. Block diagram, transfer function, unit and impulse response, signal flow graphs. Control system components, gear trains, levers, and servo mechanism; study of feedback system for automatic control of physical quantities such as voltage, speed and mechanical position. Industrial application of servo mechanism. Overview of PID controllers. Stability, Routh-Hurwitz stability criteria.

Lab Outlines

Introduction to MATLAB Control Systems Toolbox, Modelling of physical systems, linear control system modelling, LTI Systems, First and Second Order system response, computing Nyquist Criteria, root-locus and Bode plots. PI, PD and PID controllers. servo motor control.

Recommended Books
1. Control Systems Engineering by S.K. Bhattacharya, 6th edition, Pearson Education. 2. Control Systems by Norman Nise, 7th edition, Wiley. 3. Automatic Control Systems by B. Kuo, 10th edition, Wiley. 4. Linear Control System Analysis and Design with MATLAB by Constantine H. Houpis, Stuart N. Sheldon, and John J. D'Azzo, 3rd edition, CRC Press. 5. Feedback Control Systems by Gene F. Franklin, J. Da Powell, and Abbas Emami-Naeini, 5th edition, Pearson Education.

Course Content
8.25 Actuating Systems

CODE & TITLE		CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN	
(MTT-242) **Actuating Systems**		(2+1) **32 Theory + 16 Lab**	**Mechatronics Engineering Technology**	
After completion of this course students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** and apply the concepts of electronics, magnetism, induction to circuits.		C-1	1
CLO-2	**Analyze** DC machines and propose suitable machine components (windings, brushes, commutator segments, and poles).		C-4	3
CLO-3	**Calculate** parameters related to Basic Pneumatic Circuits, Pneumatic Actuators, Electro-Pneumatics and Hydraulic Systems.		C-3	2
CLO-4	**Communicate** and present the core concepts and has effective written skills for assignment/project report write-ups.		A-2	10

Course Outline for Theory

Magnetic circuits, transformers, Principles of electro-mechanical energy conversion. Faraday's law, Construction of synchronous generators and motors, Operation and performance of DC machines, Hydraulic and pneumatic actuating devices, hydraulic valve types, configuration and characteristic responses, Pneumatic valve types, configuration and characteristic responses, Design and application of hydraulic and pneumatic systems, electro-hydraulic and electro-pneumatic systems, Principles of actuator selection and methods to evaluate their performance.

Lab Outlines

Introduction to EMS and implementation of Resistive Circuits, Power Factor Calculations, Voltage Regulation in Transformer, Introduction to DC motor and generator, Speed Torque Characteristic of Shunt DC motor, Speed Torque Characteristic of Series DC motor, Speed Torque Characteristic of Compound DC motor, Speed Torque Characteristic of Separately excited Shunt generator, Speed Torque Characteristic of Self excited Shunt generator, Speed Torque Characteristic of DC compound generator, Speed Torque Characteristic of DC series generator, Introduction to Pneumatic Actuation, Force speed characteristics of Pneumatic Valves & Actuators, Introduction to Hydraulic Actuation, Force speed characteristics of Hydraulic Valves, Force speed characteristics of Hydraulic Actuators

Recommended Books
1. Electric Machinery Fundamentals, Stephen J Chapman, 5th Ed., McGraw Hill 2. Pneumatics and Hydraulic Systems, W. Bolton, 1st Ed., Butterworth-Heinemann Ltd.

Course Content

8.26 Theory and Applications of Machine Elements

CODE & TITLE (MTT-234) **Theory and Applications of Machine Elements**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 16 Lab Sessions**	**KNOWLEDGE AREA/ DOMAIN** **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the concepts of mechanics for the design of machine elements.	C-2	1
CLO-2	**Calculate** the kinematic characteristics of mechanisms such as linkages, cams, gears, governors and unbalance masses.	C-3	2
CLO-3	**Relate** analytical and/or graphical solutions to complex engineering problems in various machines and mechanisms.	C-4	3
CLO-4	**Behave** ethically, demonstrate teamwork and effectively communicate the experimental results.	A-3	12
CLO-5	**Investigate** experimentally the performance of various machine elements.	P-2	4

Course Outline for Theory

Introduction to Mechanisms, Machine & Mechanisms, Mechanism Terminology, Kinematic Diagram, Kinematic Inversion, Four Bar Mechanism, Slider Crank Mechanism, Techniques of Mechanism Analysis, Vector, Position and Displacement Analysis, Motion, Vectors, Analytical Vector Methods Applied to the Displacement Analysis of Planar Linkages, Graphical Analysis, Velocity Analysis of Mechanisms Average Speed in Mechanize Mechanism, Velocity of a Point in Mechanize Mechanism, Angular Velocity in Mechanize Mechanism, Motion of a Rigid Body about a Fixed Axis, Moving Coordinate Systems and Relative Velocity Acceleration Analysis of Mechanisms, Planar Motion, Spatial Motion, Relative Acceleration, Analysis of a Four-Bar Linkage by Analytical Vector Methods, Acceleration Analysis, Position Analysis, Time Ratio, Timing Charts, Design of Slider Crank Mechanism, Design of Crank Shaper Mechanism, Mechanism to Move a Link Between Two Positions, Cams, Governors

Lab Outline

To determine the effort required to lift a load and its efficiency by wheel and axle apparatus, to determine our effort required to lift a load and its efficiency by wheel and differential axle apparatus, To determine the mechanical advantage velocity ratio and efficiency of worm and wheel operators and draw a graph between efficiency and load. To find mechanical advantage velocity ratio and efficiency of worm and wheel apparatus and wheel and axle apparatus and plot the graph between efficiencies of both the apparatus, To investigate the motion of CAM and

follower, To determine the left off speed of governors, To calculate the performance of Flat clutch plate, To calculate the coefficients of frictions of flat, Vee and round belts with varying angles
Recommended Books
1. David H. Myszka, Machines and Mechanisms, 2nd Edition, 2002. 2. Thomas Bevan, The Theory of Machines, 3rd Edition, 2010. 3. John J. Uicker, Gordon R. Pennock, Joseph E. Shigley, Theory of Machines and Mechanisms, 5th Edition,2017

Course Content
8.27 IDTE-I

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTI-251) (IDTE-1)	(1+1) **16 Theory + 16 Lab Sessions**	**IDTE**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the approved courses for interdisciplinary engineering technologies.		

Course Content
8.28 Mechatronics Systems Design

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-341) **Mechatronics System Design**	(1+1) **16 Theory + 16 Lab Sessions**	**Mechatronics Engineering Technology**

	After completion of this course students will be able to:	Bloom's Taxonomy Level	PLO
CLO1	**Understand** and explain the fundamental concepts related to motor drives, sensors and actuators.	C-3	1
CLO2	**Design** mechatronic systems for different types of robots and automation.	C-6	3
CLO3	**Analyze** sensor based electro-mechanical systems	C-4	4
CLO4	**Demonstrate** the use of modern programming and simulation tools for developing integrated systems.	P-3	5
CLO5	**Exemplify** the advantage of integrated design approach in improving products.	A-6	10

Course Outline for Theory

Introduction, Actuators and Drives, Sensors and Interfacing, Signal Processing, Embedded Controls, Vision, Perception, Legged Robots, Wheeled Robots, Aerial-Robots, Tele-operated Robots and VR

Lab Outline

Introduction to ROS Topics, Services, Actions and Nodes. Simple interaction with the course simulation environment Overview of ROS using Python, Software representation of a Robot using Unified Robot Description Format (URDF), ROS parameter server and adding real-world object representations to the simulation environment, Nodes and Communication, Client/Server communication between nodes, Map creation with GMapping package, Autonomously navigate a known map with ROS navigation, ROS simulation tools: Gazebo and Vrep, Motion planning, pick and place behaviors using industrial robots with ROS MoveIt, Object detection, pose estimation, ROS

file system, basic concepts of behavior design with state machines, build a production line application with two industrial robot arms and a mobile robot.
Recommended Books
1. Robotics, Vision and Control: Fundamental Algorithms In MATLAB, Peter Corke, 2nd Ed, Springer 2. Computer Vision, D.H. Ballard and C.M. Brown, 1st Ed, Prentice-Hall 3. Robot Motion Planning, J.C. Latombe, 1st Ed, Springer Link 4. ROS Robotics By Example, Carol Fairchild, Dr. Thomas L. Harman, 2nd Ed, Packt Publishing

Course Content

8.29 Microcontrollers and Embedded Systems

CODE & TITLE (MTT-342) **Microcontrollers and Embedded Systems**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 16 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** and **explain** fundamental architecture of microcontrollers and microprocessors, architecture, and configuration of different microcontroller peripherals	C-3	1
CLO-2	**Design** microcontroller-based systems by interfacing with different external input/output devices	C-6	3
CLO-4	Demonstrate and implement microcontroller-based solutions	P-4	5

Course Outline for Theory

Microprocessor fundamentals, Simplified CPU organization and instruction set, Bus systems, Microprocessor architecture and Programming techniques, Structure of Intel 8086/88 microprocessor and its architecture, Pin diagram and Functions, Data sheet Descriptions, Interrupts, 8086/88 instruction set, Programming techniques, Assembly Language Programming of Intel Microprocessor, PIC16F877a Microcontroller, Input/output ports, Timers, Counters, Interfacing 7 segment display with PIC16F877a, Capture/Compare/PWM mode, Interfacing Liquid Crystal Display (LCD).

Introduction to embedded systems, General Purpose and Single Purpose Processors, Serial and Parallel communication interfaces, Synchronous Serial Interfaces, Asynchronous Serial Interfaces, Modbus, I2C Communication Interface, Open drain Configuration, I2C bus events, Arbitration and Synchronization, SPI interface and Operational Modes, CAN and LIN bus, Designing Custom Communication Protocols, Data Buffering and Parsing, Interfacing with Modern Sensors, Data Acquisition and Control.

Lab Outlines

Introduction to I/O Port Programming, Interfacing with Switches, Keypads And Displays, Capture/Compare/PWM Module, Analog Peripherals – The ADC and Comparator, Serial and Parallel communication interfaces, Synchronous Serial Interfaces, Asynchronous Serial Interfaces, Modbus, CAN and LIN bus, Designing Custom Communication Protocols, Data Buffering and Parsing, Interfacing with Modern Sensors, Data Acquisition and Control.

Recommended Books

1. The 8051 Microcontroller, Scott Mackenzy, 4th Ed., Pearson College Div
2. Programming & Customizing the PIC microcontrollers, Myke Predko, 3rd Ed., McGraw Hill, 2007
3. Microprocessor Interfacing, Daglas V. Hall, 2nd Ed., Glencoe McGraw-Hill, 1991.

Course Content

8.30 Thermal Systems and Heat Transfer

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-331) **Thermal Systems and Heat Transfer**	(2+1) **32 Theory + 16 Lab Sessions**	**Mechatronics Engineering Technology**

	After completion of this course students will be able to:	**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** different modes of heat transfer and mass transfer.	C-2	1
CLO-2	**Analyze** the heat transfer through different geometries, modes and flow regimes.	C-4	2
CLO-3	**Apply** the knowledge of heat and mass transfer to solve the problems related to Heat and Mass Transfer Applications.	C-3	2
CLO-4	**Behave** ethically and effectively communicate the experimental results.	A-3	8
CLO-5	**Investigate** experimentally the performance of various Heat and mass transfer systems.	P-2	4

Course Outline for Theory

Thermodynamic systems, chemical equation and conservation of mass in a combustion process, Nozzles, Diffusers, Compressors and Steam and Gas turbines, Heat balance sheet for thermal systems. Basic Concepts of heat flow, heat conduction, thermal conductivity, overall heat transfer coefficient, Convection, continuity equation; Natural and Forced Convection, boiling & condensation heat transfer; Thermal Radiations, radiative properties, radiation shields, Heat Exchangers design and sizing, heat exchanger operation and maintenance, extended surfaces, Fins, types of fins , Boiler: classification of Boiler, Water tube Boiler, Fire tube Boiler, Mountings and accessories of boiler, Boiler operation and maintenance, Condensers and Cooling Tower: performance evaluation of cooling towers, Efficient system operation, Flow control strategies and energy saving opportunities.

Lab Outline

Labs will be conducted on topics covered in theory such as to conduct the experimental demonstration of Fourier's law of heat conductions and determination of the Thermal conductivity "k" in a simple bar. To observe effect of cross-sectional area on heat transfer. To observe the insulating effect in a metallic bar of different diameter conductor. To obtain heat transfer coefficient (h) in free convection in flat surfaces. To obtain heat transfer coefficient in forced convection in flat surfaces. To calculate the efficiency of pinned exchangers. To calculate efficiency of finned exchangers. To obtain and plot the temperature distribution in a shell and tube heat exchanger for counter current and parallel flow. To calculate the Logarithmic mean temperature difference (LMTD) of a shell and tube exchanger. To calculate the overall heat transfer coefficient (U) in shell and tube heat exchanger.

Recommended Books
1. Y. A. Cengel and M. A. Boles, (2018), Thermodynamics, An Engineering Approach, 9th edition, McGraw-Hill 2. G. Kamaraj & P. Raveendiran (2014), Heat and Mass Transfer, 2nd edition, SciTech Publications 3. Y.A. Cengel (2007), Heat Transfer, A Practical Approach, 3rd edition, McGraw-Hill

Course Content

8.31 Computer Vision and Machine Learning

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-311) **Computer Vision and Machine Learning**	(2+1) **32 Theory + 16 Lab Sessions**	**Computing**

	After completion of this course students will be able to:	Bloom's Taxonomy Level	PLO
CLO-1	**Apply** knowledge for image recognition and classification.	C-3	1
CLO-2	**Analyze** techniques for image-based data processing.	C-4	4
CLO-3	**Apply** machine vision for robotics.	C-3	3
CLO-4	**Demonstrate** the ability to apply AI and CV techniques to engineering problems.	P-4	5
CLO-5	**Adapt** AI techniques for improving existing engineering designs.	A-3	12

Course Outline for Theory

Machine learning and deep learning focuses on learning from data to design automated systems that can improve their performance with experience. In recent years, machine learning has been used in a wide range of engineering applications, including autonomous cars, predicting mechanical failure, quality assessment, robotic vision and intelligent control among others.

This course provides a detailed overview of machine learning and deep learning with hands-on experience with its practical applications. The topics taught in this course will cover advanced principles in machine learning as well as the theoretical bases for its algorithms and how they can be optimally applied.

After completing this course, the student will be able to:

- Learn the principles of supervised, unsupervised and reinforcement learning.
- Acquiring knowledge of using ML and DL to solve practical problems relevant for engineers.

Lab Outline

Introduction to OpenCV, Image Acquisition, Image Processing, Optical Flow, Detection and Recognition, SIFT, SERF, Case study: Facial Recognition using DLIP, Introduction to AI Gym, Implementation of two Layer Neural Network, CNN: Filter Design, Feature Extraction, Case Study: Alex Net, VGG16, GoogleNet, RASNET, Time Series Data Processing, Data Cleaning, Case Study: Geo Spatial Analysis, Introduction to RNN, Detection and Segmentation, Introduction to U-Net, GANs, Introduction to AI-based Games using Reinforcement Learning

Recommended Books

1. Machine learning, Tom Mitchell, 1st Ed., McGraw Hill
2. Pattern Recognition and Machine Learning, Christopher M. Bishop, 1st Ed., Springer-Verlag
3. Deep Learning (Adaptive Computation and Machine Learning series), by Ian Goodfellow, Yoshua Bengio, Aaron Courville, 1st Ed., The MIT Press

Course Content
8.32 Depth Elective-I

CODE & TITLE (MTT-3xx) **(From Depth Elective)**	CREDIT & CONTACT HOURS (2+1) **32 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Mechatronics Engineering Technology**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of depth-elective courses defined in this curriculum. The HEI must ensure adequacy of academic and other resources for the course.		

Course Content
8.33 Project Part-1

CODE & TITLE (MTT-349) **Project Part-I**		CREDIT & CONTACT HOURS (0+3) **0 Theory + 48 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Mechatronics Engineering Technology**
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Apply** and Identify background knowledge of engineering fundamentals in proposed idea and compare with previous related.	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 knowledge of sustainable development.	C-5	11
CLO-4	**Develop** a wide range of technical skills by delivering a working prototype using latest design tools that has passed through the design, implementation, testing and evaluation stages.	C-6	3
CLO-5	**Integrate** the solution of Complex Engineering problem for improvement of Society or Environment.	A-4	8
CLO-6	**Practice** various methods to avoid Plagiarism in reports to adapt ethical values.	A-5	8
CLO-7	**Organize** effectiveness as an individual and in a teamwork management.	A-4	9
CLO-8	**Display** their communication skills through presentations, technical reports, and posters.	A-5	10

CLO-9	**Display** the results of hardware components testing which could be used for SDP.	P-5	5

Course Content
8.34 Management Sciences Elective-II

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTM-301) **(From Management Sciences Electives)**	(3+0) **48 Theory + 0 Lab Sessions**	**Management Sciences**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of Management Sciences elective courses defined in this curriculum. The HEI must ensure adequacy of academic and other resources for the course.		

Course Content
8.35 Introduction to Robotics

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-343) **Introduction to Robotics**	(2+1) **32 Theory + 16 Lab Sessions**	**Mechatronics Engineering Technology**

	After completion of this course students will be able to:	Bloom's Taxonomy Level	PLO
CLO-1	**Understand** and explain the fundamental robot configurations and types, and the basic terminologies related to robotics.	C-2	1
CLO-2	**Analyze** robot configurations through forward and inverse kinematics.	C-4	4
CLO-3	**Develop** and Implement path and trajectory planning in manipulators/mobile robots.	C-3	3
CLO-4	**Operate** a robotic arm using teach pendent/programming.	P-3	5

Course Outline for Theory

Introduction, Actuators and Drives, Control Components, Control Software – 1, Sensors, Robot Kinematics: Forward and Inverse, Robot Kinematics: Jacobina and Velocities, Differential Motion, Statics and Energy method, Hybrid position and force control, Compliance and End effector design, non-holonomic systems, Navigation, Legged Robots, Wheeled Robots, Aerial Robots, Tele operated Robots and VR

Lab Outline

De-mining Robot: Embedded Robot Controller, I/O Interface, and PWM Amplifiers, De-mining Robot: Controller Software and Sensor Inputs, De-mining Robot: Implement Basic Sensor-based Controls; Plan Strategy for De-mining Task, De-mining Robot: Refine De-mining Operations, Robot-Concept Design, Robot-Implementation, Robot System Integration

Recommended Books

1. Robot Analysis and Control, H. Asada, J.-J. E. Slotine., 1st Ed, Wiley
2. Robotics, Vision and Control: Fundamental Algorithms In MATLAB, Peter Corke, 2nd Ed, Springer
3. Introduction to Robotics, John J. Craig, 3rd Ed, Pearson

4. Computer Vision, D.H. Ballard and C.M. Brown, 1st Ed, Prentice-Hall
5. Robot Motion Planning, J.C. Latombe, 1st Ed, Springer Link
6. Introduction to Robotics, P. J. McKerrow, 1st Ed, Addison-Wesley

Course Content
8.36 Industrial Automation

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-344) **Industrial Automation**	(2+1) **32 Theory + 16 Lab Sessions**	**Mechatronics Engineering Technology**

	After completion of this course students will be able to:	Bloom's Taxonomy Level	PLO
CLO-1	**Understand** and explain fundamental practices of automation and manufacturing for industrial units and processes.	C-2	1
CLO-2	**Design** PLC based systems and Develop automation solutions and CNC programs using machine codes.	C-6	3
CLO-3	**Analyze** and debug ladder logic programs and CNC codes.	C-4	4
CLO-4	**Demonstrate** the ability to write PLC and CNC programs using modern tools.	P-4	5
CLO-5	**Exemplify** the use of PLC and CNC based automation technology in various products.	A-6	12

Course Outline for Theory

Overview of PLCs, Central Processing Unit, I/O System, Programming Terminals and Peripherals, Installation and maintenance of PLCs, Relay Logic, Ladder Logic, Timers and Counters, Program Flow Instructions, Sequencers and Data Transfer, Math Functions, Process Control and Data Communications, Number Systems and Codes (G and M-codes), Digital Logic, RTUs & PACs, Introduction to SCADA-based Automation.

Lab Outline

Overview of PLC hardware, Ladder logic: Installation, Contact and Coils, Binary and Boolean logic, Seal in circuits, Timers and Counters, Numbering Systems (), Advanced Instructions, HMI and SCADA, Introduction to C-More, Introduction to Factory View Studio, Introduction to Easy Builder, Introduction to Wonder Ware

Recommended Books

1. Fundamentals of PLCs, Sensors and Communication, Jon Stenerson, 3rd Ed., Prentice Hall
2. Robots and Manufacturing Automation, C. Ray Asfahl, 2nd Ed, Wiley
3. CAD/CAM Principles and Applications, P N Rao, 3rd Ed, McGraw Hill
4. Programmable Controllers: An Engineer's Guide, E. A. Parr, 3rd Ed, Newnes
5. Automation Production Systems and Computer-Integrated Manufacturing, Mikell P. Groover, 5th Ed, Prentice Hall
6. Machine Tool Technology Basics, Steve Krar, Arthur Gill, Peter Smid and Paul Wanner, Har/Cdr Ed, Industrial Press, Inc.

Course Content
8.37 Depth Elective-II

CODE & TITLE (MTT-3xx) **(From Depth Elective)**	CREDIT & CONTACT HOURS (2+1) **32 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Mechatronics Engineering Technology**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of depth elective courses defined in this curriculum. The HEI must ensure adequacy of academic and other resources for the course.		

Course Content
8.38 IDTE-II

CODE & TITLE (MTI-352) (IDTE-1)	CREDIT & CONTACT HOURS (1+1) **16 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **IDTE**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the approved courses for interdisciplinary engineering technologies.		

Course Content
8.39 Project Part-II

CODE & TITLE (MTT-349) **Project Part-II**	CREDIT & CONTACT HOURS (0+3) **0 Theory + 48 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Mechatronics Engineering Technology**	
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 a Broadly Define Engineering Technology Problem.	C-6	3
CLO-2	**Implement** proposed design using modern technology for solution of Broadly Define Engineering Technology Problem.	C-3	5
CLO-3	**Investigate** and analyze the results obtain from the implemented design.	C-4	4
CLO-4	**Practice** ethical principles (Plagiarism in particular) and engineering norms.	A-5	8
CLO-5	**Display** effectiveness as an individual and in a teamwork management.	A-4	9

CLO-6	**Display** their communication skills through presentations, technical reports, and poster.	A-5	10
CLO-7	**Demonstrate** management skills as a member and/or leader to manage the project.	A-4	11
CLO-8	**Alter/Revise** the conventional solutions by adapting modern technology.	P-6	12

Course Content
8.40 Social Sciences Elective

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTH-401) **(From Humanities and Social Sciences Electives)**	(2+0) **32 Theory + 0 Lab Sessions**	**Humanities and Social Sciences**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of Humanities and Social Sciences elective courses defined in this curriculum. The HEI must ensure adequacy of academic and other resources for the course.		

Course Content
8.41 Management Sciences Elective-III

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTM-401) **(From Management Sciences Electives)**	(2+0) **32 Theory + 0 Lab Sessions**	**Management Sciences**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of Management Sciences elective courses defined in this curriculum. The HEI must ensure adequacy of academic and other resources for the course.		

Course Content
8.42 Depth Electives-III-VI

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-4xx) **(From Depth Electives)**	(2+1) **32 Theory + 16 Lab Sessions**	**Mechatronics Engineering Technology**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of depth-elective courses defined in this curriculum. The HEI must ensure adequacy of academic and other resources for the course.		

Course Content
8.43 Computing Elective

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-411) **(From Computing Electives)**	(1+1) **16 Theory + 16 Lab Sessions**	**Computing**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of computing elective courses defined in this curriculum. The HEI must ensure adequacy of academic and other resources for the course.		

Course Content

8.44 Entrepreneurship

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTM-108/301/401) **Entrepreneurship**	(3+0) **48 Theory + 0 Lab sessions**	**Management Science**

	After completion of this course students will be able to:	**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Demonstrate** the understanding of entrepreneurship concept as a whole and the role of entrepreneurship in economic development.	A-3	11
CLO-2	**Compare** the role and importance of the small and medium sized enterprises in the economy.	A-4	6
CLO-3	**Apply** the ability to find an attractive market and apply the understanding of business planning concept for new business creation and growth.	A-3	9

Course Outline for Theory

The concept of entrepreneurship, the economic 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. Technology Ventures: From Idea to Enterprise by Thomas Byers, Richard Dorf, Andrew Nelson, 4th Edition, McGraw Hill 2015, (or Latest edition)
2. Paul Burns and Jim Dew Hurst: "Small Business and Entrepreneurship", 1996, Palgrave Macmillan Publishing Company, Second Edition (or Latest edition)
3. Peter F. Drucker: "Innovation and Entrepreneurship", 2006, Harper Business, Reprint Edition (or Latest edition)
4. The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company by Steve Blank, Bob Dorf, K & S Ranch 2012, (or Latest edition)
5. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful

Businesses by Eric Ries, Penguin Books 2011, (or Latest edition)
6. John B. Miner, “Entrepreneurial Success”, 1996, Berrett-Koehler Publishers, First Edition (or Latest edition)

Course Content

8.45 Project Management

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/DOMAIN
(MTM-108/301/401) **Project Management**	(2 + 0) **32 Theory + 0 Lab**	**Management Science**

After completion of this course students will be able to:		Bloom's Taxonomy Level	PLO
CLO-1	**Describe** and understand the basic concepts of management with a special focus on project management.	A-1	11
CLO-2	**Demonstrate** competency in various project management knowledge areas, project scheduling and controlling techniques including Critical Path Method and Earned Value Management.	A-3	11
CLO-3	**Use** computers in Project Management, especially a tool like MS Project & Primavera etc.	C-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. Project Management: A System Approach to Planning Scheduling and Controlling by Harold Kerzner, 11th edition, John Willey 2013, (or Latest edition) 2. Project Management: A managerial approach 7th edition, Jack R. Meredith and Samuel J. Mantel, Jr. John Wiley and Sons, Inc. Project Management for Business, (or Latest edition) 3. Project Management for Engineering and Technology: Principles and Practice 3rd Edition, by John M. Nicholas and Herman Steyn, Elsevier Publications (or Latest edition) 4. Project Management: A Strategic Planning Approach by Paul Gardiner, 2nd Edition, Palgrave Macmillan, 2017, (or Latest edition)

Course Content
8.46 Economics

CODE & TITLE (MTH-401) Economics	CREDIT & CONTACT HOURS (3+0) 48 Theory + 0 Lab Sessions	KNOWLEDGE AREA/ DOMAIN Humanities and Social Sciences	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Estimate** the depreciation of an asset using standard depreciation techniques to assess its impact on present or future value.	C-2	11
CLO-2	**Predict** the cost effectiveness of individual projects using the methods learnt and the effects of inflation on economic analysis of engineering projects.	C-3	6
CLO-3	**Analyze** the appropriate engineering economics analysis method(s) for problem solving i.e., present worth, annual cost, rate of return, payback, break-even, benefit-cost ratio.	C-4	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. Technological Economics by Shoubo Xu (Springer), (Latest Edition)
2. Engineering Economy, Latest Edition, Leland T. Blank and Anthony J. Tarquin, McGraw Hill, (Latest Edition)
3. Contemporary Engineering Economics, Latest edition, Chan S Part Pearson Prentice Hall (Latest Edition)
4. Engineering Economic Analysis by Donald G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, 12th edition, Oxford University Press, (or Latest Edition)

Course Content

8.47 Numerical Analysis

CODE & TITLE (MTN-107) **Numerical Analysis**		**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 16 Lab Sessions**	**KNOWLEDGE AREA/ DOMAIN** **Natural Science-Elective**	
After completion of this course students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Comprehend** different numerical techniques such as error propagation, interpolation, differentiation, integration, eigenvalues and solution of algebraic and differential equations.		C-2	1
CLO-2	**Apply** the numerical techniques to different linear and nonlinear engineering problems		C-3	2
CLO-3	**Apply** proper software tools and techniques of MATLAB Programming for developing Numerical Computation solutions		P-3	5

Course Outline for Theory

Mathematical preliminaries and error analysis, round- off errors and computer arithmetic, Divided Differences, use of Divided-difference Table. Newton's Interpolation Polynomial, Interpolation with Equally Spaced Data, Newton's Forward & Backward Difference Formulae, Gauss Formulae, Stirling's Interpolation Formula, Bessel's Interpolation Formula, Solution of Nonlinear Equations by Bisection Method, Regula Falsi, Secant, Newton-Raphson Method, Fixed Point Iteration. Solution of Equations by Jacobi Iterative Methods, Gauss Seidel Method. Numerical Differentiation, Numerical Differentiation Formulae Based on Equally Spaced Data. Numerical Differentiation Based on Newton's Forward Differences. Numerical Differentiation Based on Newton's Backward Differences. Numerical Differentiation Based on Stirling's Formula. Numerical Differentiation Based on Bessel's Formula. Numerical Differentiation Based on Lagrange's Formula. Factorization for Linear System.

Lab Outlines

Introduction to MATLAB. Newton Raphson & Bisection Method. False Position & Secant Method. Linear system of equations. Extreme Value Theorem. Gauss Elimination method with backward substitution. LU Factorization for Linear System. Crout factorization of Tridiagonal Linear System S. Jacobi Method of solving linear systems. Gauss Siedel Method of solving linear systems and Lagrange's interpolation. Newton's Divided Difference Interpolation Method. Natural Cubic Spline Method. Open-ended Lab.

Recommended Books

1. Numerical Analysis (9thEdition) by Richard L. Burden, J. Douglas Faires by Brooks/ Cole Boston USA, 2011
2. Numerical Methods for Scientific Computing by J.H. Heinbockel Trafford Publishing USA, 2006
3. Applied Numerical Analysis, by C. F. Gerald and P. O. Wheatley, seventh edition.
4. Numerical Methods Using MATLAB by John H. Mathews and Kurtis D. Fink, fourth edition.
5. Numerical Mathematics and Computing by W. Cheney and D. Kincaid, Sixth edition.

6. E. Kreyszig, Advanced Engineering Mathematics, 9th edition, Wiley, 2006.
7. A. Greenbaum & T. P. Chartier, Numerical Methods, Princeton University Press, 2012.
8. D. P. O'Leary, Scientific Computing with Case Studies, SIAM, 2008.

Course Content

8.48 Parallel and Distributed Computing

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(MTT-41x) **Parallel and Distributed Computing**	(2+0) **32 Theory**	**Computing**

	After completion of this course students will be able to:	Bloom's Taxonomy Level	PLO
CLO-1	**Under** and explain the fundamental concepts of parallel and distributed computing.	C-2	1
CLO-2	**Develop** portable programs for parallel or distributed architectures using Message-Passing Interface (MPI) library.	C-6	3
CLO-3	**Analyze** complex problems with shared memory programming using open MP.	C-4	4

Course Outline for Theory

Asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).

Recommended Books

1. Distributed Systems: Principles and Paradigms, A. S. Tanenbaum and M. V. Steen, 2nd Edition, Prentice Hall
2. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Jack Dongarra, Geoffrey C. Fox, 1st Ed., Morgan Kaufmann

Course Content

8.49 Artificial Intelligence

CODE & TITLE (MTT-41x) Artificial Intelligence	CREDIT & CONTACT HOURS (2+0) 32 Theory Sessions	KNOWLEDGE AREA/ DOMAIN Computing	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** and explain the fundamental concepts of AI and Lisp programming language.	C-2	1
CLO-2	**Analyze** the various AI techniques.	C-4	4
CLO-3	**Apply** artificial intelligence techniques through various case studies.	C-3	2

Course Outline for Theory

An Introduction to Artificial Intelligence and its applications towards Knowledge Based Systems; Introduction to Reasoning and Knowledge Representation, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, Min- max algorithm, Alpha beta pruning, Game-playing); Case Studies: General Problem Solver, Eliza, Student, Macsyma; Learning from examples; Natural Language Processing; Recent trends in AI and applications of AI algorithms. Lisp & Prolog programming languages will be used to explore and illustrate various issues and techniques in Artificial Intelligence.

Recommended Books

1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, 4th Ed, Pearson
2. Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp, Peter Norvig, 1st Ed., Morgan Kaufmann
3. AI algorithms, data structures, and idioms in Prolog, Lisp, and Java, George Luger, William Stubblefield, 6th Ed., Pearson.

Course Content
8.50 Digital Twin

CODE & TITLE (MTT-41x) Digital Twin	CREDIT & CONTACT HOURS (2+0) 32 Theory Sessions + lab	KNOWLEDGE AREA/ DOMAIN Computing	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** and explain the basics concepts regarding digital twins.	C-2	1
CLO-2	**Develop** programs to implement/update digital twins.	C-6	3
CLO-3	**Model** and simulate the various techniques of digital twin technology.	C-4	5

Course Outline for Theory

Introduction to Structural Health Monitoring by Digital Twins, Why DT Modelling and simulation?, A review of various DT models (static versus dynamic), The FMU/FMI concept (how to integrate solvers and DT models), How to implement a SHM solution with DTs (Python and low-code tools.), Common structural failure modes (fatigue, buckling, yield etc.), How to monitor assets like cranes, bridges, windmills, machinery and vehicles, A review of physical sensors used in structural monitoring, How and why eliminate noise and drifting of sensor outputs, Low-pass, high pass filtering and FFT analysis, Python or Modellica programming.

Recommended Books

1. Digital Twin Technology: Fundamentals and Applications, Manisha Vohra, 1st Ed., Wiley-Scrivener
2. Building Industrial Digital Twins: Design, develop, and deploy digital twin solutions for real-world industries using Azure Digital Twins, by Shyam Varan Nath, Pieter van Schalkwyk, Dan Isaacs, 1st Ed., Packt Publishing

Course Content
8.51 AR and VR

CODE & TITLE (MTT-41x) **AR and VR**		CREDIT & CONTACT HOURS (2+0) **32 Theory Sessions + 0 lab**	KNOWLEDGE AREA/ DOMAIN **Computing**	
After completion of this course students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** and explain the fundamental concepts of AR and VR as modern tools.		C-2	1
CLO-2	**Develop** various programs for various AR and VR systems.		C-6	3
CLO-3	**Demonstrate** the use of AR and VR system by developing interactive systems.		P-4	5

Course Outline for Theory

Historical Overview, Current Trends and Future applications of Immersive Technologies, Best practices in VR,AR and MR including design, prototyping and an ethical code of conduct, Overview of human physiology, psychology and usability factors, A critical framework for evaluating current and emerging immersive reality technologies and applications, Design and Technological foundations for Immersive Experiences, Input devices – controllers, motion trackers and motion capture technologies for tracking, navigation and gestural control, Output devices – Head Mounted VR Displays, Augmented and Mixed reality glasses, 3D interactive and procedural graphics, Immersive surround sound, Haptic and vibrotactile devices, Systems architecture and integrative immersive media platforms, Rapid prototyping and physical computing, VR programming

Recommended Books

1. Handbook of Virtual Environments: Design, Implementation, and Applications, Kelly S. Hale, Kay M. Stanney, 2nd Ed., CRC Press
2. Computer Graphics And Virtual Environments: From Realism to Real-Time, Mel Slater, Anthony Steed, Yiorgos Chrysanthou, 1st Ed., Addison-Wesley

Course Content

8.52 Introduction to Data Science

CODE & TITLE (MTT-41x) Introduction to Data Science	CREDIT & CONTACT HOURS (1+1) 16 Theory + 16 Lab Sessions	KNOWLEDGE AREA/ DOMAIN Computing	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** and explain the fundamental concepts of data science and the related terminologies.	C-2	1
CLO-2	**Apply** EDA and the Data Science process to a case study and implement machine learning algorithms to solve technological problems.	C-3	5
CLO-3	**Demonstrate** a thorough understanding of Python programming language by implementing various machine learning techniques.	P-4	5

Course Outline for Theory

Introduction: What is Data Science? Big Data and Data Science hype, Datafication, Current landscape of perspectives, Skill sets needed; Statistical Inference: Populations and samples, Statistical modeling, probability distributions, fitting a model, Intro to Python; Exploratory Data Analysis and the Data Science Process; Basic Machine Learning Algorithms: Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes; Feature Generation and Feature Selection; Dimensionality Reduction: Singular Value Decomposition, Principal Component Analysis; Mining Social-Network Graphs: Social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs; Data Visualization: Basic principles, ideas and tools for data visualization; Data Science and Ethical Issues: Discussions on privacy, security, ethics, Next-generation data scientists.

Lab Outline

Statistical Inference: Populations and samples, Statistical modeling, probability distributions, fitting a model, Intro to Python; Exploratory Data Analysis and the Data Science Process; Basic Machine Learning Algorithms: Linear Regression, k-Nearest Neighbors (k-NN), k-means, Naive Bayes; Feature Generation and Feature Selection; Dimensionality Reduction: Singular Value Decomposition, Principal Component Analysis; Mining Social-Network Graphs: Social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs; Data Visualization

Recommended Books

1. Foundations of data science, Avrim Blum, John Hopcroft, Ravindran Kannan, 1st Ed., Cambridge University Press
2. An Introduction to Data Science, Jeffrey S. Saltz, Jeffrey M. Stanton, 1st Ed., SAGE Publications
3. Python for everybody: Exploring data using Python 3, Dr. Charles Russell Severance, Sue Blumenberg, Elliott Hauser, Aimee Andrion, 1st Ed., CreateSpace Independent Pub
4. Doing Data Science, Straight Talk from the Frontline, Cathy O'Neil, Rachel Schutt, 1st Ed., O'Reilly
5. Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, EMC Education Services, 1st Ed., Wiley

Course Content

8.53 Renewable Energy Technology

CODE & TITLE (MTT-32x/42x) **Renewable Energy Technology**	CREDIT & CONTACT HOURS (2+0) **32 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Demonstrate** the fundamental characteristics of different renewable energy sources and mechanisms to harness these technologies.	C-3	1
CLO-2	**Compare** traditional energy sources and renewable energy sources to analyze their impact on the environment and society.	C-5	6
CLO-3	**Operate** equipment and practice the design of the characteristics of various renewable source configurations,	P-3	4
CLO-4	**Express** the observations during a power plant visit and write a comprehensive report.	A-3	8

Course Outline for Theory

Introduction to Renewable Energy Systems: Worldwide 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 the system, Payback period, Maintenance Cost. Grid Connected Systems: Exploitation of Alternate energy sources, Review of the present energy state of energy sector, Different sources of energy, Components of power systems, and 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

Lab Outlines

Learn the use of basic renewable energy gadgets. Study the various concepts and characteristics of renewable energy sources. Visit a thermal and solar power plant.

Recommended Books

1. Alternative Energy Sources by Efstathios E. Stathis Michaelides, Springer.
2. Renewable Energy by Bent Sorensen, Elsevier.

3. Fundamentals of Renewable Energy Processes by Aldo Vieira Da Rosa, Academic Press.
4. "Renewable Energy Conversion, Transmission, and Storage" by Bent Sorensen, Elsevier.

Course Content

8.54 Signals and Systems

CODE & TITLE (MTT-32x/42x) **Signals and Systems**	CREDIT & CONTACT HOURS (1+1) **16 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Demonstrate** an understanding of fundamental concepts in different types of continuous and discrete-time signals and systems.	C-3	1
CLO-2	**USE** system tools, especially convolution, and transformations, to determine the behavior of continuous and discrete-time signals and systems.	C-3	2
CLO-3	**Confirm** basic concepts of programming in MATLAB, express knowledge of handling matrices and explain the use of built-in functions to perform assigned tasks, and state how to use SIMULINK.	P-1	1
CLO-4	**Produce** signals, apply transforms, and manipulate and feed signals to systems as per the needs.	P-3	2
CLO-5	**Report** the outcome of the experiments/ tasks.	A-1	8

Course Outline for Theory

The course covers the fundamentals of signal and system analysis, focusing on representations of discrete-time and continuous-time signals (complex exponentials, Fourier representations, and Laplace transforms. Representations of linear, time-invariant systems (difference and differential equations, system functions, poles and zeros, convolution, impulse and step responses, frequency responses).

Lab Outline

In Signal and systems lab course, the student will acquire hands-on experience with programming in MATLAB. MATLAB will enable students to study and understand the theory behind signals and systems as well as validate the theory with real-world examples. The labs will cover linear time-invariant systems, Fourier series, and Fourier transform, sampling, and digital filters.

Recommended Books

1. Signals and Systems by Alan V. Oppenheim, Alan S. Willi sky and S. Hamid Nawab, 2nd Edition, Prentice Hall.
2. Signals, Systems, and Transforms by Charles L. Phillips, John Parr, and Eve A. Riskin, 5th Edition, Pearson Education.

Course Content
8.55 Electrical Machines

CODE & TITLE (MTT-32x/42x) Electrical Machines		CREDIT & CONTACT HOURS (2+1) 32 Theory + 16 Lab Sessions	KNOWLEDGE AREA/ DOMAIN Mechatronics Engineering Technology	
After completion of this course students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Appl**y the concepts of magnetic fields to analyze magnetic circuits and the principle of operation of a transformer and compute various parameters of the transformer.		C-3	2
CLO-2	**Use** and compute the various parameters of ac motors and generators, their equivalent circuits, rotating magnetic field, the induced voltage and torque, phasor diagrams, and the relationships between speed, power, torque, and applications.		C-3	2
CLO-3	**Calculate** the various parameters of DC generators and motors, their equivalent circuits, and the relationships between speed, power, torque, and applications.		C-3	2
CLO-4	**Perform** experiments in a laboratory enabling the students to gain insight into the functioning of transformers, AC and DC machines.		P-4	2

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 autotransformers, 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. Electrical Machines, Drives, and Power Systems by Theodore Wildi, 7th edition, Pearson Education.
2. Electric Machinery Fundamentals by Stephen J. Chapman, 5th edition, McGraw-Hill Education.
3. Electric Machines: Theory, Operating Applications, and Controls by Charles I. Hubert, 2nd Edition, Pearson.

Course Content
8.56 Power Electronics

CODE & TITLE (MTT-32x/42x) **Power Electronics**		CREDIT & CONTACT HOURS (2+1) **32 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/DOMAIN **Mechatronics Engineering Technology**	
After completion of this course students will be able to:			**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Discuss** power electronic circuits for applications in controlled and uncontrolled rectification.		C-2	1
CLO-2	**Analyze** the designed circuits for their performance parameters.		C-4	2
CLO-3	**Perform** experiments in the laboratory related to power Electronics.		P-4	8

Outline for Theory

Principles of Power Electronics: converters and applications, circuit components and their effects, control aspects.

Power Electronic Devices: Power diode, power BJT, power MOSFET, IGBT and SCR, GTO, TRIAC, and DIAC. Construction Characteristics: Operations, losses, ratings, control and protection of thyristors, half-wave and full-wave rectifiers with resistive and inductive loads, un-controlled, semi controlled and fully controlled rectifiers, three-phase rectifiers: un-controlled, semi controlled and full controlled, six-pulse, PWM converters, DC to AC converters, three-phase inverter, six-pulse, PWM inverters, switching mode power supplies, DC to DC conversation, buck converter, boost converter and buck-boost converters, isolated converters, forward converters, flyback converters.

Lab Outline

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

Recommended Books

1. Power Electronics: Circuits, Devices and Applications, M. H. Rashid, Pearson.
2. Power Electronics, C. W. Lander, 3rd edition, McGraw Hill.
3. Power Electronics, D. W. Hart, 1st edition, McGraw Hill.
4. Elements of Power Electronics, Philip T. Krein, 1st edition, Oxford University Press.

Course Content
8.57 Smart Grid Technology

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/DOMAIN
(MTT-32x/42x) **Smart Grid Technology**	(2+1) **32 Theory + 16 Lab Sessions**	**Mechatronics Engineering Technology**

	After completion of this course students will be able to:	**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the technologies and methodologies used in the smart electrical grids.	C-2	1
CLO-2	**Analyze** intelligent electrical power system dynamics in smart grid technology.	C-4	2
CLO-3	**Operate** smart grid trainer for hands-on practice on several components and modules.	P-3	4
CLO-4	**Conduct** experiments in the laboratory to interpret experimental data and observe its conformance using an integrated approach.	P-4	8

Outline for Theory

Introduction to Smart Grid: Integrated networks, renewable energy sources, and modelling, 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.

Lab Outline

Demonstration on smart grid trainer having a simulation of main energy sources (wind, hydro, solar, and coal) and power supplies. Perform experiments 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. Smart Grid and Enabling Technologies: Shady S. Reffat et.al, Willey- IEEE Press.
2. Smart Grid Technology: A Cloud Computing Data Management Approach by Sudip Misra and Samaresh Bera, Cambridge University Press
3. Smart Grid, Technology and Applications by Janaka Ekanayake et al., Wiley

4. Smart Grids Fundamental and Technologies in Electricity Networks by Bernd M. Buchholz and Zbigniw Styczynski, Springer.

Course Content
8.58 Sensor Network

CODE & TITLE (MTT-32x/42x) **Sensor Network**	CREDIT & CONTACT HOURS (2+1) **32 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/DOMAIN **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** communication, network protocols, and topologies of sensor networks.	C-2	1
CLO-2	**Solve** industrial problems using sensor networks.	C-3	4
CLO-3	**Perform** experiments related to IoT and sensor networks.	P-1	5
CLO-4	**Adapt** various communication protocols for industrial sensing and control applications.	P-6	3

Outline for Theory

Different types of industrial sensor communication networks and topologies, data communication basics, communication model, routing, localization and synchronization, sensor fusion and aggregation, protocols such as Zigbee, Bluetooth Low Energy (BLE), or LoRa, compressive sensing graph signal processing. security measures in wireless sensor networks. Energy harvesting techniques for sensor network. Industrial networks: OSI reference model, industry network and their selection, network architectures, modbus and fieldbus, Highway Addressable Remote Transducer (HART) Protocol, MQTT protocol, wireless protocols and ZigBee. Key components that make up an IoT system, levels of the IoT stack and key technologies and protocols employed at each layer of the stack.

Lab Outline

Design and configure different types of wireless sensor network topologies such as star, mesh, and tree networks, and analyze their performance in terms of data transmission, energy consumption, and network resilience. Configure the wireless sensor nodes to establish communication with the base station and enable sensor data transmission. Collect data from different sensor nodes and aggregate it at the base station using protocols such as Zigbee, Bluetooth Low Energy (BLE), or LoRa. Implement security measures in wireless sensor networks such as encryption, authentication, and access control. Integrate energy harvesting techniques such as solar, thermal, or kinetic energy harvesting into wireless sensor nodes. Implement and analyze different routing protocols such as Ad-hoc On-demand Distance Vector (AODV), Destination-Sequenced Distance Vector (DSDV), and Optimized Link State Routing (OLSR) in wireless sensor networks. Deploy a wireless sensor network in a real-world environment and evaluate its performance in terms of data accuracy, range, and reliability. Integrate wireless sensor networks with IoT platforms such as AWS IoT or Google Cloud IoT.

Recommended Books
1. Foundational Elements of an IoT Solution: J. Biron and J. Follett, O'Reilly Media, 2016. 2. Wireless Sensor Network Designs: Anna Hac, John Wiley & Sons, December 2003.

Course Content

8.59 Telecommunication System Technology

CODE & TITLE (MTT-32x/42x) **Telecommunication Systems Technology**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 16 Lab Sessions**	**KNOWLEDGE AREA/DOMAIN** **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** different principles involved in communication systems and recognize each in different communication systems.	C-1	1
CLO-2	**Analyze** the different modulation techniques in terms of signal-to-noise ratio along with their comparison.	C-4	4
CLO-3	**Perform** experiments in the laboratory related to communication systems.	P-4	8

Outline for Theory

Introduction to Communication Systems (at block level): Information, transmitter, channel, receiver, & modulation. Noise: Types of noises, bandwidth & review of Fourier Series and Fourier Transforms, orthogonal signals, power spectrum density, heterodyning & commercial radio receiver, signal to noise ratio, noise figure, dBm, dBW, evaluating the effect of noise in different techniques of AM and their comparison in terms of signal to noise ratio Sensitivity &

Selectivity: Hilbert transform & single side band (SSB), modulation generation & detection, analyzing Frequency division multiplexing, Vestigial side band (VSB) modulation, angle modulation: Frequency & Phase modulation: Narrow & wideband FM, Bandwidth approximation in FM.

Generation and detection of FM signals, generation and detection of PM signals, comparison of FM & PM. Analog to Digital Conversion: Sampling theorem, quantization & coding (types, error, and implementation). Pulse modulation: Pulse Amplitude Modulation, Pulse Width Modulation, & Pulse Position Modulation.

Digital Modulation: Amplitude shift keying (ASK, OOK), Frequency shift Keying (FSK, OTS). Analyze Time division Multiplexing, Digital base band signals format in time & frequency domain. To Analyze Phase shift keying (PSK), Minimum shift keying (MSK). Evaluating M-ary modulation (4PSK, QAM etc), Bit error rate in digital communication

Lab Outline

Generate a Gaussian noise sequence with zero mean and variance. Process a binary data stream using a communication system that consists of baseband modulator, channel and demodulator. Simulate BER of system and plot BER vs SNR. Simulate QPSK modulation scheme and compare it to BPSK scheme. Study cellular systems

using their simulators. Plot relative power drop of the signal at a mobile station.
Recommended Books
1 . Digital Communications, Principles and Applications (2nd Edition) by Bernard Sklar, Pearson Education 2 . Introduction to Communication Systems, by Ferral G. Stemler, Addison-Wesley Educational Publishers 3 . Communication Systems, 5th Edition by Simon Haykin and Michael Moher, 5th edition, John Wiley & Sons Inc. 4 . Fundamentals of Communication Systems 2nd Edition by John Proakis and Masoud Salehi, 2nd edition, Pearson.

Course Content

8.60 Energy and Power Technologies

CODE & TITLE (MTT-33x/43x) **Energy and Power Technologies**	CREDIT & CONTACT HOURS (2+1) **32 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Comprehend** the social and economic benefits of Renewable resources for Pakistan.	C-2	6
CLO-2	**Analyze** Renewable energy resources conversion and energy storage systems.	C-4	2
CLO-3	**Calculate** the Environmental impact and sustainability of energy resources.	C-2	7
CLO-4	**Behave** ethically, demonstrate teamwork and effectively communicate the experimental results.	A-3	8
CLO-5	**Investigate** performance of various energy and power systems.	P-2	4

Course Outline for Theory

Energy and power technologies, Conventional and non-conventional energy systems, fossil fuels, IC engines: types, performance, emission measurement and controls, alternative fuels for IC engines, Jet engines, types and applications, Thermal power plants, Hydro electric energy, Renewable energy systems, (Nuclear power system, wind energy, solar energy, energy from biomass geothermal, tidal and wave energy, hydrogen gas as renewable energy resource), energy storage technologies, Hybrid power technologies, energy audit and energy conservation, ISO 50001,

Lab Outline

Familiarization with renewable energy gadgets. Familiarization with solar energy gadgets. Measure the electricity generation by solar panel. Solar panel in parallel and series with load. Fill Factor and IV curve of Solar Power. Effects of different time of the day on solar powe. Energy audit and Inspection. To study the valve timing diagram of four stroke SI engine. To study the emission characteristics of IC Engine. To draw the performance curve of Hydrogen generation unit. To study the working of jet engine model. To study the difference between electric and conventional vehicle

Recommended Books
1. Paul Breeze, (2014), Power Generation Technologies, 2nd edition 2. M. M El-Wakil, (1985), Powerplant Technology, McGraw Hill, international edition. 3. John Twidell & Tony Weir, (2015), Renewable Energy Resources, 3rd edition, Routledge

Course Content

8.61 Finite Element Analysis

CODE & TITLE (MTT-33x/43x) **Finite Element Analysis**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 16 Lab Sessions**	**KNOWLEDGE AREA/ DOMAIN** **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the fundamental theories used in FEA to solve various engineering problems.	C-2	01
CLO-2	**Design** and evaluate FEA models by applying initial and boundary conditions and meshing techniques.	C-5	03
CLO-3	**Apply** the FEA software for structural analysis of various solid parts.	P-2	05

Course Outline for Theory

The basics of Finite Element analysis, Matrix forces methods, Matrix stiffness method, Minimum energy formulation and recent developments. Finite element modelling, element division and numbering scheme, basic steps to solve problems in FEA (preprocessor, processor, and post-processor), Finite element analysis of 1D, 2D and 3D trusses, beams, plate and Frames. Variational formulations and Boundary value problems. Rayleigh Ritz methods, method of weighted residuals, time-dependent problems.

Lab Outline

Fluid mechanics and solid mechanics problems. Finite element error analysis: Approximation errors, various measures of errors. Convergence of solutions, accuracy of solutions. Interpolating functions, numerical integration and modeling considerations. Interpolating techniques: Triangular, rectangular and serendipity elements: coordinate transformation Integration on a master element, modeling, mesh generation, load representation. Plane elasticity: Assumptions of plane elasticity: Basic equations, weak formulations: principle of virtual displacement in matrix form: finite element model matrix and weak form model: evaluation of integral.

Recommended Books

1. Advanced Strength and Applied Stress Analysis by Richard G. Budynass, McGraw Hill, 2nd Edition 1977/2015.
2. Finite Element Analysis-Theory and Application by Saeed Moaveni, Prentice Hall, 3rd Edition,2015.
3. Finite Element Procedures by K.J. Bathe, 1st Edition, 1996.

Course Content

8.62 Industrial Maintenance and Safety

CODE & TITLE (MTT-33x/43x) **Industrial Maintenance and Safety**	CREDIT & CONTACT HOURS (2+1) **32 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the importance of plant and equipment maintenance, its types and different systems of maintenance.	C-2	01
CLO-2	**Discuss** maintenance and safety plans, illustrate accidents prevention measures and standards.	C-2	02
CLO-3	**Practice** the Experimental Task and writing skills as per subject requirements (List of Practical of each course).	P-3	04
CLO-4	**Organize** report in a given format.	A-4	10

Course Outline for Theory

Importance of plant maintenance, factors influencing the maintenance, Considerations in designing plant maintenance, economic aspects of maintenance, care and maintenance of common industrial equipment (like bearings, piping, filters, pumps, compressors, and lubricating systems), maintenance linkage to safety, different systems/types of maintenance, laws of accident proneness, accident preventions. Legal, humanitarian & economic reasons to prevent accidents, safety measures, analysis & procedures, safety equipment, OHSAS 18000.

Lab Outline

Lab experiments may be related to care and maintenance of common industrial equipment (like bearings, piping, valves, filters and strainers, alignments, pumps, turbine, compressors, pressure vessel, and lubricating systems), maintenance linkage to safety, color coding, job safety analysis. If possible, tutorials or demos or videos may be shown to the students which covers Computer based Maintenance Management System (MMS) software, SAP or similar.

Recommended Books

1. Engineering Maintenance by S. Dhillon, Ph.D. CRC press, 1st edition, 2019.
2. R. Keith Mobley Editor in Chief, Lindley R. Higgins and Darrin J. Wikoff, Maintenance engineering handbook 8th edition, 2014.
3. Maintenance Planning and Control by Anthony Kelly, reprint, 1984.
4. Mohmad Ben-Daya, Salih O. Duffuaa Abdul Raouf et. al. Handbook of Maintenance Management and

Engineering, 2009.

Course Content

8.63 Metrology and Quality Assurance

CODE & TITLE (MTT-33x/43x) **Metrology and Quality Assurance**	CREDIT & CONTACT HOURS (2+1) **32 Theory + 16 Lab Sessions**	KNOWLEDGE AREA/ DOMAIN **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** line and end standards, interferometry, comparators, Taylor's theory of gauging systems, limits and fits.	C-1	01
CLO-2	**Understand** the design of limit gauges' angular measurement. sine bar, angle gauges, autocollimators.	C-2	01
CLO-3	**Practice** the Experimental Task as per subject requirements (List of Practical of each course).	P-3	04
CLO-4	**Organize** report in a given format.	A-4	10

Course Outline for Theory

Introduction to the line and end standards, linear measurement errors. Interferometry comparators. Taylor's Theory of Gauging Systems of Limits and Fits.B.S 4500. Design of Limit Gauges Angular Measurements. Sine bar, Angle gauges, Measurement of internal taper Alignment and perpendicularity measurement, Autocollimators, Measurement of roundness. Gear Measurement and Testing, Measurement of Surface Texture. Control charts for variables and attributes. Acceptance Sampling, Operating characteristic curves, Reliability. Quality Management Systems and Standards. ISO-9000

Lab Outline

To understand line and end standards, Interferometry, comparators, Taylor's theory of gauging systems, limits and fits, B.S, to understand the design of limit gauges' angular measurement. Sine bar, angle gauges, autocollimators, To understand Quality management systems

Recommended Books

1. Fundamentals of Dimensional Metrology by Dotson, Harlow, Thompson, 6TH edition, 2015.
2. Quality Control by Besterfield, 8TH edition,2008.
3. Statistical Quality Control by Grant & Leavenworth, 7th edition, 1996.

Course Content
8.64 Arial Robotics

CODE & TITLE (MTT-34x/44x) Aerial Robotics	CREDIT & CONTACT HOURS (1+1) 16 Theory + 16 Lab Sessions	KNOWLEDGE AREA/ DOMAIN Mechatronics Engineering Technology	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** and explain the basic concepts regarding aerial dynamics, path planning and flight control.	C-1	1
CLO-2	**Design** simulate and implement drone control using open-source flight controllers.	C-5	3
CLO-3	**Investigate** different type of sensors for a multi-constraint environment for feedback.	C-4	4
CLO-4	**Demonstration** of state estimation techniques like Kalman Filter in MATLAB/ROS that provides the essential system variables (signals) required for implementing advanced path planning and control algorithms for flight control.	P-4	5
CLO-5	**Formulate** architectures for SLAM and SWARM based flight control.	A-4	5

Course Outline for Theory

This course aims to introduce concepts of the holistic design of autonomous aerial robots. The focus of the course will be on Unmanned Aerial Vehicle design, data acquisition through sensors and incorporation of intelligence for autonomous flight control. The course will also build the concepts of hardware and software related to Autonomous Flight Stack Implementation including UAV's dynamics, flight control, simultaneous localization and mapping, path planning and autonomous navigation. A brief introduction to the Robot Operating System and Flight Controllers will also be taught as a part of this course.

Lab Outline

Introduction to ROS Topics, Services, Actions and Nodes. Simple interaction with the course simulation environment Overview of ROS using Python, Software representation of a robot using Unified Robot Description Format (URDF), ROS parameter server and adding real-world object representations to the simulation environment, ROS simulation tools: Gazebo and Vrep, Drone Design in ROS: Fixed wing and Quadcopters, Map creation with GMapping package, autonomously navigate a known map with ROS navigation, Motion planning with single drone: Concept of SLAM

Motion planning with multi-drones: Concepts of SWARM, Introduction to Pixhawk controllers, Implementation of flight navigation and control on DJI Tello drones, Swarm Intelligence implementation on DJI Tello drones

Recommended Books
1. Springer Handbook of Robotics, Bruno Siciliano, Oussama Khatib, 2nd Ed, Springer
2. Handbook of Unmanned Aerial Vehicles, K. Valavanis, P. Vachtsevanos, 2015th Ed, Springer
3. Small Unmanned Aircraft: Theory and Practice, R. Beard, and T. W. McLain, 2nd Ed, Princeton University Press
4. Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, Brian L. Stevens, Frank L. Lewis, Eric N. Johnson, 3rd Ed, Wiley-Blackwell

Course Content

8.65 Modeling and Simulations

CODE & TITLE (MTT-34x/44x) **Modeling and Simulation**	**CREDIT & CONTACT HOURS** (2+0) **32 Theory + 0 lab**	**KNOWLEDGE AREA/ DOMAIN** **Mechatronics Engineering Technology**	
After completion of this course students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** and explain the fundamental modelling components, and the different types of systems to be modelled.	C-1	1
CLO-3	**Apply** fundamental techniques derive the differential equations and to calculate the parameters of the system.	C-3	2
CLO-5	**Design** and simulate engineering models.	C-6	5

Course Outline for Theory

This course explores modeling of mechanical systems (springs, dampers, mass, translational and rotational systems, geared systems), Modeling of electrical systems (capacitor, inductor, resistors, and analog electronic devices), Modeling of hydraulic and pneumatic systems, Mechatronics systems (Electromechanical, fluid –mechanical and Electro-hydraulic systems), System dynamic response analysis (frequency response),State space analysis, Numerical techniques, time response and digital simulation, stochastic simulation, Monte Carlo methods.

Recommended Books

1. Modeling and Simulation of Dynamic Systems, Robert L. Woods and Kent L. Lawrence, 1st Ed., Pearson
2. Modeling and Analysis of Dynamic Systems, by Charles M. Close, Dean K. Frederick, Jonathan C. Newell, 3rd Ed., Wiley
3. Modeling and Simulation of Systems Using MATLAB and Simulink, Devendra K. Chaturvedi, 1st Ed., CRC Press

9. Laboratories Detail

Sr. No.	Lab Names	Lab Equipment/Apparatus	Lab Courses
1.	Instrumentation and Controls Lab	Lab View for Window (Starter Kit) with accessories NI Elvis Kit with accessories Instrumentation and Transducer trainer with accessories Desktop PC with accessories PID control trainer with accessories HBM Quantum X Data Acquisition System Electrical control trainer with accessories Digital Storage Oscilloscope with accessories DC Power Supply with accessories Function Generator with accessories Breadboard with accessories multi-meter with accessories Logic Probes Fuzzy Logic trainer with accessories Electro-mechanical trainer with accessories FPGA Trainer Kit with add -ons ModBUS, Profibus, Ethernet and Field bus systems Consumables Desktop PCs with accessories Stepper motor with drive circuit, Servo motor kits with drive circuit DC motor kits with drive circuit Microprocessor Training Kit MTS 88c with accessories Consumable equipment (LED, Bread Board.	1. Instrumentation and Measurement 2. Linear Control Systems 3. Actuating systems 4. Micro Controllers and Embedded Systems Design
2.	Electronics Lab	Digital Storage Oscilloscope with accessories DC Power Supply with accessories Function Generator with accessories Breadboard with accessories multi-meter with accessories Logic Probes Digital LCR Meter, DLT Logic Trainers with add -ons, DLD Trainer Consumables Desktop PCs with accessories	1. Electronics Devices and Circuits 2. Digital Logic Design 3. Applied Physics
3.	Computer Lab	PC (core i-7) along with Keyboard, mouse, Display PC and accessories	1. Computer Programming Fundamentals 2. Computer Programming for AI
4.	Industrial Automation and Robotics Lab	PLC trainer kits with add-ons PLC training simulator Didactic equipment with accessories Mobile robot with accessories Industrial grade robotic arm with accessories Desktop PC with accessories Robotic Arm with robotic vision kit and accessories	1. Industrial Automation 2. Introduction to Robotics
5.	Fluid Mechanics Lab	Flow Visualization Equipment Flow Visualization Tank Dye Injection System	Thermo-Fluids

		Smoke Generator Manometer, Pressure Transducers, Venturi meter, Orifice Plates, Rotameters, Centrifugal Pumps, Hot Wire Anometer, Sieve Shakers	
6.	Mechanics of Materials Lab	Universal Testing Machine, Extensometer, Load Cells. Hardness Testers, Impact Testing Equipment, Fatigue Testing Equipment, Torsion Testing Apparatus, Strain Gauges, Optical Microscope,	1. Mechanics Theory and Applications 2. Applied Physics
7.	Heat and Mass Transfer Lab	Heat Exchangers, Calorimeters, Thermal Conductivity Columns, Distillation Columns, Absorption Columns, Membrane Separation Units, Heat Flux Sensors, Anemometers, Evaporators and Conductors, Heat Transfer Education Kits	Thermal Systems and Heat Transfer

10. Supervised Industrial Training

10.1 Background

Supervised Industrial Training refers to students supervised hands-on experience in an environment where engineering is practiced, familiarizing them with professional engineering work prior to graduation. The training curriculum consists of minimum 16 weeks of continuous industrial training, comprised of 8 hours per day, 5 working days per week. A Bachelor of Engineering Technology student shall undergo mandatory SIT during the 8th semester (16 weeks), or 7th and 8th semesters (16 weeks mandatory and 16 weeks in 7th semester optional), after he/ she has passed all subjects up to 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 practices and the curriculum to achieve Program Learning Outcomes that cover Engineering Technologists Graduate Attributes in line with the Sydney Accord. While SIT provides practical exposure to engineering 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.

10.2 Objectives:

Through the SIT, students will:

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

10.3 Responsibility of HEI: Placement in SIT Program

During 7th (Optional) and 8th semester, Bachelor of Mechatronics Engineering Technology students will be undergoing continuous SIT of 16 (or 32) weeks. This training shall be arranged by HEIs in leading industry, and preferably should sign an MoU for the SIT. A designated Administrator/Coordinator of 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 the students are aware and assured of undergoing SIT training in 7th (optional) and 8th semester according to a scheduled timeline.

10.4 Responsibilities of Students:

a. Bachelor of 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 of 8 hours daily for 5 days (40 contact hours) will be counted as 1 credit hour. Accordingly, 16 weeks (One semester) will help 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. If an HEI opts SIT in 2 semesters (7th and 8th), these credit hours and contact hours will be doubled.

d. Students will maintain a daily Logbook, signed by the SIT supervisor at site, Training Administrator appointed by HEI and the student.
e. Students must observe safety & security rules of the Organization where they receive Training.
f. Students must wear specified working dress during training.
g. Students must obey all rules and regulations of the organization.
h. Students must observe working timings of the training Organization. Students may be allowed 10 days leave during the Training period of 16 (or 32) for genuine reasons. The leave shall only be used to cater for emergencies, with prior sanction from the training Administrator/Coordinator.
i. Leave will be deducted from training hours and required to be made up later.
j. Unsanctioned leaves shall be treated as "absent", and liable to disciplinary action.
k. Public holidays and leave should not be counted as working hours.

10.5 Training Progress Assessment and Review by HEI

Every HEI should appoint a focal person as SIT Administrator/Coordinator for each program who will monitor progress randomly through 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/Coordinator are:

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 discussion with training supervisor(s).
c. To make courtesy visits and establish industrial relations between the HEI and the industries where students will 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.

10.6 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 training Administrator/Coordinator, if a new placement of the student is available and confirmed in another organization, provided the student does not suffer loss of training hours due to this changeover.
c. After getting written permission from the Training Administrator/Coordinator, a fresh approval should be applied for the new placement.

10.7 Daily Training Logbook

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

The Training logbook must reflect:

a. The student's learning experience during the industrial training
b. Training records and evidence of supervised training, with evidence of participation of student, on- the-job Trainer and HEI's training Administrator/Coordinator.
c. Part of professional practice in engineering profession where incidence and evidence are properly documented.
d. Information that becomes a source of reference in preparing the Industrial Training Report.

e. The Logbook must be submitted along with the Industrial Training Report.

10.8 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 practices and professional skills acquired through practical experience. The Industrial Training Report should also reflect a student's ability in communication skills and understanding of engineering practices. Students should seek advice from their on-the-job Trainer at site, to ensure that no confidential materials are included in the report. The report shall be submitted to the Training Administrator. The student may present a copy of the report to the prospective employer. Any references made in preparation of the report should be recognized using standard referencing formats. Students should refer to the Industrial Training Report Template as provided [See Appendix G] and guidelines given below in preparing the Report. The Daily Training Logbook should be submitted together with the Report.

10.9 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:

10.10.1 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 & 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. Backgrounds/profile of the organization
ii. Vision and Mission
iii. Organogram.
iv. Title and position of the supervisor in charge
v. Other necessary information only (not more than three pages)

(c) Schedule of Duties Performed as 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, if any.
ii. Supervisory works
iii. Problems encountered

iv. Problems solving process or approach
v. Hands-on skills acquired.
vi. How productivity can be further enhanced.
vii. Quality Management system in place.
viii. Safety at work.

(e) Conclusion

Students provide an overall assessment in this section and arrive at a conclusion with regards to the SIT undergone. Content 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 the 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, so far these are not secret documents or proprietary etc.
iii. Any other document that adds 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.

10.10.2 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 of maximum 2 pages, and should briefly describe:

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

10.10 SIT Assessment

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

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

It is also to be noted that:

i. Minimum 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 and figurative form.
v. If the Report is not satisfactory, students shall rewrite the Report until it is deemed satisfactory.

10.11 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 and/or probable employer.
ii. The Confirmation Letter must be submitted to the Industrial Training Administrator/Coordinator, together with the (1) On-the-Job Trainer's Report, (2) Student Feedback Form, and (3) Industrial Training Report for grading.

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. Preliminary meeting of National Curriculum Review Committee (NCRC) in the discipline of Mechatronics Engineering Technology for bachelor's degree program was held on 25-01-2023 to 27-01-2023 for 3 days at the University of Wah (UoW), Wah Cantt.

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 UoW, Wah Cantt. 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. He highlighted the agenda of this meeting and emphasized adaptation of general rules of curriculum development and revision such as scope of the subject/program, horizontal & vertical alignment, rule of flexibility and adaptability. Moreover, scope and template for adopting new undergrad policy was discussed to adopt for the uniformity and alignment of curriculum.

4. In the first session, Honorable Prof. Dr. Jameel-Un Nabi , Vice Chancellor, The University of Wah (UoW), Wah Cantt shared procedure and execution of agenda in NCRC. Then he invited the house to nominate the Convener, Co-Convener, Secretary of the NCRC for smooth functioning. After discussion with members Dr. Shaukat Ali nominated as Convener, and Prof. Dr. Muhammad Asif, Dr. Abid Imran were nominated as Co-Convener, Secretary for the Committee, respectively. Following nominated members represented various HEIs from all over the Pakistan in NCRC for B.Sc. Mechatronics Engineering Technology.

Sr#	NCRC Members	Role
1.	Engr. Dr. Shaukat Ali Assistant Professor and Chairperson, University of Wah, Wah Cantt	Convener
2.	Engr. Prof. Dr. Muhammad Asif Professor Ziauddin University, Karachi	Co-Convener
3.	Engr. Dr. Abid Imran Assistant Professor GIK Institute of Engineering Sciences and Technology, Topi	Secretary
4.	Engr. Dr. Syed Ali Raza Shah Associate Professor and Dean Balochistan University of Engineering and Technology Khuzdar	Member
5.	Engr. Dr. Mudaser Ullah Assistant Professor University of Sargodha, Sargodha	Member
6.	Engr. Dr. Muhammad Jawad Khan Assistant Professor, NUST, Islamabad	Member

Sr#	NCRC Members	Role
7.	Engr. Prof. Dr. Abdul Aziz Mazhar Professor, Institute of Space Technology, Islamabad	Member
8.	Engr. Prof. Dr. Shahab Khushnood Professor University of Wah, Wah Cantt	Member
9.	Engr. Dr. Waseem Shahzad Assistant Professor, University of Wah, Wah Cantt	Member
10.	Engr. Dr. Muhammad Yasir Assistant Professor, University of Wah, Wah Cantt	Member
11.	Engr. Dr. Shahid Mehmood Assistant Professor, University of Engineering & Technology, Taxila	Member
12.	Mr. Hafiz Ghulam Muhammad NTC, Pakistan	NTC Representative

5. After taking charge by the nominated Committee, Convener, Engr. Dr. Shaukat Ali chaired the meeting and emphasized to ensure the reflection of Sydney Accord in curriculum and course titles as well as to develop curriculum that provides a unified framework for offering degrees under the title of Mechatronics Engineering Technology.

6. In continuation of given guidelines, Dr. Shaukat Ali, Convener, Prof. Dr. Muhammad Asif, Convener and Dr. Abid Imran, Secretary highlighted the objectives of curriculum development.

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 Mechatronics 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 Bloom's 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 the needs of society.

8. In the next session, the house 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 Mechatronics Engineering Technology

10. Furthermore, the 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 the 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 Bloom's Taxonomy and PLOs, updating list of contents, adding teaching-learning methods and assessment, and updating bibliography/ references/ suggested books.
17. The following Core Committee, along with four Sub-Committees, were constituted.

Mechatronics Engineering Technology Core Committee		
Sr#	**Name**	**Role**
1	Engr. Dr. Shaukat Ali	Convener
2	Engr. Prof. Dr. Muhammad Asif	Co-Convener
3	Engr. Dr. Abid Imran	Secretary
1. Sub-Committee: Computing and Mechatronics Courses (Core and Electives)		
Sr#	**Name**	**Role**
1	Engr. Dr. Muhammad Jawad Khan	Member
2	Engr. Dr. Waseem Shahzad	Member
3	Engr. Dr. Shahid Mehmood	Member
2. Sub-Committee: Electrical Engineering/Electronics Courses (Core and Electives)		

Sr#	Name	Role
1	Engr. Prof. Dr. Muhammad Asif	Member
2	Engr. Dr. Shaukat Ali	Member
3	Engr. Dr. Abid Imran	Member
3. Sub-Committee: Mechanical Courses (Core and Electives)		
2	Engr. Prof. Dr. Shahab Khushnood	Member
3	Engr. Dr. Muhammad Yasir	Member
4	Engr. Dr. Syed Ali Raza Shah	Member
5	Engr. Dr. Mudaser Ullah	Member

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

19. The initial draft is complained by secretary Dr. Abid imran and shared with respected committee members to finalize the assigned course contents in all aspects before final meeting.

APPENDIX E: Minutes of the Final Meeting of NCRC

1. The final meeting of the NCRC in the discipline of Mechatronics Engineering Technology for the bachelor's degree program was held on 03-05-2023 to 05-05-2023 for 03 days at the University of Wah (UoW), Wah Cantt.

2. The inauguration session started with recitation of Holy Quran and chaired by Honorable Registrar of University of Wah.

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 mechatronics engineering technology. He further requested the NCRC committee to identify the minimum number of labs and minimum required equipment in each lab for BSc mechatronics engineering technology program.

4. The Chair also extended his gratitude to the entire team and briefed the objectives and arrangements for the final NCRC.

5. Mr. Hafiz Ghulam Muhammad represented NTC.

6. The following members attended the meeting:

Sr#	NCRC Members (Name, Designation and Affiliation)	Role
1.	Engr. Dr. Shaukat Ali Assistant Professor and Chairperson, University of Wah, Wah Cantt	Convener
2.	Engr. Prof. Dr. Muhammad Asif Professor Ziauddin University, Karachi	Co-Convener
3.	Engr. Dr. Abid Imran Assistant Professor GIK Institute of Engineering Sciences and Technology, Topi	Secretary
4.	Engr. Dr. Mudaser Ullah Assistant Professor University of Sargodha, Sargodha	Member
5.	Engr. Dr. Muhammad Jawad Khan Assistant Professor, NUST, Islamabad	Member
6.	Engr. Prof. Dr. Abdul Aziz Mazhar Professor, Institute of Space Technology, Islamabad	Member
7.	Engr. Prof. Dr. Shahab Khushnood Professor University of Wah, Wah Cantt	Member
8.	Engr. Dr. Waseem Shahzad	Member

Sr#	NCRC Members (Name, Designation and Affiliation)	Role
	Assistant Professor, University of Wah, Wah Cantt	
9.	Engr. Dr. Muhammad Yasir Assistant Professor, University of Wah, Wah Cantt	Member
10.	Engr. Dr. Shahid Mehmood Assistant Professor, University of Engineering & Technology, Taxila	Member
11.	Mr. Hafiz Ghulam Muhammad NTC, Pakistan	NTC Representative

7. After the introductory session, deliberations on the agenda of the second meeting formally commenced which was headed by Convener Engr. Dr. Shaukat Ali, Co-Convener Engr. Prof. Dr. Muhammad Asif, Secretary Engr. Dr. Abid Imran.

8. After long deliberation, the committee proposed the required lab and minimum number of equipment required in each lab for Mechatronics Engineering Technology. The proposed labs and equipment are included in this curriculum.

9. The core/elective courses content and overall curriculum is reviewed by the convener and shared with the international experts for their valuable feedback.

10. The final draft was compiled by Secretary Engr. Dr. Abid imran and shared with committee members for final review.

11. After review by Members and with the approval of Convener Engr. Dr. Shaukat Ali and Co-Convener Engr. Prof. Dr. Muhammad Asif, it was submitted to NTC.

APPENDIX F: Supervised Industrial Training Logbook Sample Format

Personal 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:

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.

_____
Trainee signature with date

_____
Supervisor signature with date

APPENDIX G: Supervised Industrial Training Report Sample Format

Sample table of content for supervised industrial training report is provided so that students can develop an understanding of what is expected of them when making the 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 trainee is also to be attached at the beginning of the submitted report.