Curriculum

For

Bachelor of Biomedical Engineering Technology Degree

(2023)

Higher Education Commission
Islamabad
Curriculum Division

Acronyms, Abbreviations & Definitions

Acronym/ Abbreviation	Definition
HEC	Higher Education Commission
NTC	National Technology Council
NCRC	National Curriculum Review Committee
IDEE	Integration of Data in Engineering Environment
IEA	International Engineering Alliance
IDTE	Inter Disciplinary Technology Elective
MATLAB	Matrix Laboratory
HEI	Higher Education Institution
RIC	Resistance, Inductance, Capacitance
IEEE	Institute of Electrical and Electronics Engineers
SIT	Supervised Industrial Training
LTI	Linear Time-Invariant System
BJT	Bipolar Junction Transistor
MOSFET	Metal–Oxide–Semiconductor Field-Effect Transistor
IGBT	Insulated-Gate Bipolar Transistor
Th	Theory
Lab	Laboratory
Cr. Hrs.	Credit Hours
PLO	Program Learning Outcome
CLO	Course Learning Outcome
ICT	Information and Communications Technology
OSI	Open Systems Interconnection
LAN	Local Area Network

WAN	Wide Area Network
MAN	Metropolitan Area Network
RMS	Root Mean Square
Hb	Hemoglobin
CBC	Complete Blood count
WBC	White Blood Cells
pH	Potential of Hydrogen
TLC	Thin-Layer Chromatography
HPLC	High Performance Liquid Chromatography
DNA	Deoxyribonucleic acid
RNA	Ribonucleic acid
ATP	Adenosine Triphosphate
OGTT	Oral Glucose Tolerance Test
ODEs	Ordinary Differential Equations

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 Biomedical 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 Biomedical 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).
- To run affairs smoothly, right at the start NCRC Members elect from among themselves a Coordinator, a co-Coordinator, and a Secretary to steer, control and record proceedings.
- 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 NCRC meetings to develop Bachelor of Biomedical Engineering Technology are enlisted below:

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

3. Curriculum Details

Bachelor of Biomedical Engineering Technology Program			
Parameter	**HEC Framework**	**Framework - A (SIT in 7th & 8th Semesters)**	**Framework - B (SIT in 8th Semester Only)**
Program Type	Semester System	Semester System	Semester System
Program Duration	8 Semesters Min: 4 Years Max: 7 Years	8 Semesters Min: 4 Years Max: 7 Years	8 Semesters Min: 4 Years Max: 7 Years
Semester Duration	16 weeks of Teaching 2 weeks for Exams	16 weeks of Teaching 2 weeks for Exams	16 weeks of Teaching 2 weeks for Exams
Total Number of Courses	41	38	43**
Engineering Technology Domain Courses	28	24	28**
Non-Engineering Technology Domain Courses	13	14	15**
Total Credit Hours	124 – 136	133	133
Engineering Technology Domain Credit Hours	85	93	90
Percentage of Engineering Technology Domain Courses	74.42%	69.90%	67.67%
Non-Engineering Technology Domain Credit Hours	39	40	43
Percentage of Non-Engineering Technology Domain Courses	25.58%	30.10 %	32.33 %
No. of Credit Hours per Semester	15 – 18	15 – 18	15 – 18
** Optional Courses may be included for Framework B (SIT in 8th only)			
1 credit hour: (1) For theory: 1 contact hour per week for a minimum of 16 weeks for theory. (2) For practical's: 3 contact hours per week for a minimum of 16 weeks for practical's.			

Engineering Technology Domain Courses in

Recommended Schemes of Studies as per Framework

Knowledge Area	Name of Course	Credit Hours (Th+Lab)	Weekly Contact Hours (Th+Lab)	Total Credit Hours		Number of Courses	
				As per Scheme of Studies	As per Framework	As per Scheme of Studies	As per Framework
Computing	Information and Communication Technology	1+1=2	1+3=4	6	6	2	3
	Computer Programming	1+1=2	1+3=4				
Biomedical Engineering Technology (Foundation)	Workshop Practices	0+1=1	0+3=3	10	18	5	9
	Technical Drawing	0+1=1	0+3 =3				
	Basic Electrical Technology	2+1=3	2+3 =5				
	Human Anatomy & Physiology	3+1=2	3+3=6				
	Electrical Circuit Analysis	2+1=3	2+3=5				
Biomedical Engineering Technology (Breadth)	Digital Logic Design	2+1=3	2+3=5	18	11	6	4
	Signals and Systems	2+1=3	2+3=5				
	Biomechanics	2+1=3	2+3=5				
	Molecular Biology	2+1=3	2+3=5				
	Biomaterials	2+1=3	2+3=5				
	Biomedical Instrumentation	2+1=3	2+3=5				
Biomedical Engineering Technology (Depth)	Microprocessors and Microcontrollers	2+1=3	2+3=5	22	14	9	5
	Biomedical Control Systems	2+1=3	2+3=5				
	Medical Imaging Devices	2+1=3	2+3=5				
	Clinical Laboratory Equipment	2+1=3	2+3=5				
	Troubleshooting of Medical Devices	0+1=1	0+3=3				
	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	3+0=3	3+0=3				
IDEE	IDTE-I	3+0=3	3+0=3	5	5	2	2
	IDTE-II	2+1=2	2+3=5				
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=16	16**		0	
	Supervised Industrial Training	0+16=16	0+16=16	16		0	
Total Credit Hours and Courses (For Engineering Technology Domain Courses)		93	43+149=192	99-92		26-25	
** Optional Courses may be included for Framework B (SIT in 8th Semester only)							

Non-Engineering Technology Domain Courses in

Recommended Schemes of Studies as per Framework

Knowledge Area	Sub-Area	Name of Course	Credit Hours (Th+Lab)	Weekly Contact Hours (Th+Lab)	Total Credit Hours		Number of Courses	
					As per Scheme of Studies	As per Framework	As per Scheme of Studies	As per Framework
Humanities and Social Sciences	English (Expository Writing)	Communication Skills	3+0=3	3+0=3	6	6	2	2
		Technical Report Writing	2+0=3	3+0=3				
	Culture	Islamic Studies / Social Ethics	3+0=3	3+0=3	6	6	2	2
		Pakistan Studies	3+0=3	3+0=3				
	Social Sciences Electives	Elective-I	3+0=3	3+0=3	6	9	2	3
		Elective-II	3+0=3	3+0=3				
Management Sciences	Management Sciences	Elective-I	3+0=3	3+0=3	5	6	2	2
		Elective-II	2+0=2	2+0=2				
Natural Sciences	Math (Quantitative Reasoning)	Basic Mathematics*	3+0=3	3+0=3	8/11*	6	3/4*	3
		Calculus and Analytical Geometry	3+0=3	3+0=3				
		Linear Algebra & Differential Equations	3+0=3	3+0=3				
		Probability and Statistics	2+0=2	2+0=2				
	Biology	Basic Biology**	2+1=3	2+3=5	3**/0	3	0/1**	1
	Physics	Applied Physics	3+1=4	3+3=6	4	4	1	1
	Chemistry	Biochemistry Forced Elective	2+1=3	2+3=5	3	3	1	1
Total Credit Hours and Courses • * for Pre-Medical students • ** for Pre-Engineering students ** Optional Courses may be included for Framework B (SIT in Semester 08 only)					Cr. Hrs. **41/47**		Courses **13 /15**	

List of Elective Topics	
Social Sciences	**Management Sciences**
➢ Professional Ethics ➢ Sociology for Technologist ➢ Critical Thinking ➢ Organizational Behavior ➢ Professional Psychology and Human Behavior ➢ Elective Courses by HEI*	➢ Fundamentals of Economics ➢ Project Management ➢ Entrepreneurship ➢ Principles of Marketing ➢ Leadership and Personal Grooming ➢ Elective Courses by HEI*
Natural Sciences*	
➢ Biomedical Signal Processing ➢ Biotelemetry System ➢ Medical Device Quality System and Standards ➢ Medical Device Regulatory Affairs ➢ Power Electronics ➢ Medical Robotics ➢ Rehabilitation Techniques ➢ Tissue Engineering Technology ➢ Drug Delivery Systems ➢ Artificial Intelligence ➢ Bioinformatics ➢ Medical Image Processing ➢ Hospital Information System ➢ Elective Courses by HEI*	
*Any related course can be included in the list above, subject to approval of the HEI's Statutory Bodies. Maximum allowed courses per elective knowledge area are limited to 3.	

4. Admission Criteria

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

1. At least 50% marks in DAE/FSc (Pre-engineering) or other equivalent qualifications such as A-levels/ICS/B.Sc. (sports and Hafiz-e-Quran marks are not counted), and
2. Entrance Test
3. Weighted average score for admission is calculated by:
    - 70% for academics (DAE/FSc etc.)
    - 30% for Entrance Test

5. Semester-wise Scheme of Studies

Semester-wise scheme of studies for Bachelor of Biomedical Engineering Technology program spanning 4 years, spread over 8 semesters, and totaling 129 credit hours is presented below, along with weekly contact hours for each course.

SEMESTER I				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
BIN-111/ BIN-112	Basic Biology (for Pre-Engineering Students)/ Basic Mathematics (for Pre-Medical Students)	Natural Sciences	2+1 or 3+0	2+3 or 3+0
BIH-111	Communication Skills	Humanities	3+0	3+0
BIH-112 BIH-113	Islamic Studies/Social Ethics	Humanities	3+0	3+0
BIN-113	Applied Physics	Natural Sciences	3+1	3+3
BIC-111	Information & Communication Technology	Computing	1+1	1+3
BIT-111	Workshop Practices	Foundation	0+1	0+3
BIT-112	Technical Drawing	Foundation	0+1	0+3
	Subtotal		**12+5 = 17 or 13+4 = 17**	**27 or 24**
SEMESTER-II				**Weekly Contact Hrs. (Th+Lab)**
Suggested Course Codes	**Course Title**	**Knowledge Area/Domain**	**Credit Hrs. (Th+Lab)**	
BIN-121	Calculus and Analytical Geometry	Natural Sciences	3+0	3+0
BIT-121	Basic Electrical Technology	Foundation	2+1	2+3
BIT-122	Human Anatomy & Physiology	Foundation	3+1	3+3
BIC-121	Computer Programming	Computing	1+1	1+3
BIM-121	Management Sciences Elective I	Management Sciences	3+0	3+0
BIS-121	Social Sciences Elective I	Social Sciences	3+0	3+0
	Subtotal	**13+3 =16**	**15+3 =18**	**24**

SEMESTER-III				Weekly Contact Hrs. (Th+Lab)
Course Codes	**Course Title**	**Knowledge Area**	**Credit Hrs. (Th+Lab)**	
BIN-211	Biochemistry	Natural Sciences Forced Elective	2+1	2+3
BIN-212	Linear Algebra & Differential Equations	Natural Sciences	3+0	3+0
BIT-211	Electrical Circuit Analysis	Foundation	2+1	2+3
BIT-212	Digital Logic Design	Breadth	2+1	2+3
BIS-211	Social Sciences Elective II	Social Sciences	3+0	3+0
	Subtotal		**12+3=15**	**21**

SEMESTER-IV				Weekly Contact Hrs. (Th+Lab)
Course Codes	**Course Title**	**Knowledge Area**	**Credit Hrs. (Th+Lab)**	
BIT-221	Signals and Systems	Breadth	2+1	2+3
BIT-222	Electronic Devices and Circuits	Foundation	2+1	2+3
BIT-223	Microprocessors and Microcontrollers	Depth	2+1	2+3
BIT-224	Biomechanics	Breadth	2+1	2+3
BIT-225	Molecular Biology	Breadth	2+1	2+3
BIM-221	Management Science Elective II	Management Sciences	2+0	2+0
	Subtotal		**12+5 =17**	**27**

SEMESTER-V				Weekly Contact Hrs. (Th+Lab)
Course Codes	**Course Title**	**Knowledge Area**	**Credit Hrs. (Th+Lab)**	
BIT-311	Biomaterials	Breadth	2+1	2+3
BIT-312	Biomedical Instrumentation	Breadth	2+1	2+3
BIT-313	Biomedical Control Systems	Depth	2+1	2+3
BIH-311	Pakistan Studies	Humanities	3+0	3+0
BIE-311	Technical Report Writing	Humanities	2+0	2+0
BIT-314	Project-I	Project	0+3	0+9
	Subtotal		**9+8 =17**	**29**
SEMESTER-VI				**Weekly Contact Hrs. (Th+Lab)**
Course Codes	**Course Title**	**Knowledge Area**	**Credit Hrs. (Th+Lab)**	
BIT-321	Medical Imaging Devices	Depth	2+1	2+3
BIN-321	Probability and Statistics	Natural Sciences	2+0	2+0
BIT-322	Clinical Laboratory Equipment	Depth	2+1	2+3
BII-321	IDTE-I	IDTE	3+0	3+0
BII-322	IDTE-II	IDTE	2+1	2+3
BIT-323	Project-II	Project	0+3	0+9
	Subtotal		**11+6 =17**	**29**

SEMESTER-VII				**Weekly Contact Hrs. (Th+Lab)**
Course Codes	**Course Title**	**Knowledge Area**	**Credit Hrs. (Th+Lab)**	
ELT-411	**Supervised Industrial Training (Optional)**	**Biomedical Engineering Technology Domain Industrial Training**	**16**	**40 (per Week)**
BIH-411 BIM-411	Management Sciences Elective-III	Management Sciences	3+0	3+0
BIT-412	Depth Elective-I	Depth	2+1	2+3
BIT-413	Depth Elective-II	Depth	2+1	2+3
BIT-414	Depth Elective-III	Depth	2+1	2+3
BIT-415	Troubleshooting of Medical Devices	Depth	0+1	0+3
BIT-416	Depth Elective-IV	Depth	3+0	3+0
	Subtotal		**12+4=16**	**24**
SEMESTER-VIII				**Weekly Contact Hrs. (Th+Lab)**
Course Codes	**Course Title**	**Knowledge Area**	**Credit Hrs. (Th+Lab)**	
BIT-421	**Supervised Industrial Training (Compulsory)**	**Biomedical Engineering Technology Domain Industrial Training**	**16**	**40 (per Week)**
	Subtotal		**0+16= 16**	**0+40= 40**
Total Credit Hours & Contact Hours in Four Years (When SIT conducted in both 7th and 8th Semester)			**64+65=133**	**64+195=259**
Theory vs Practical with respect to Contact Hours			Theory Practical	64 (24.71%) 195 (75.29%)
Total Credit Hours & Contact Hours in Four Years (When optional courses conducted instead of SIT in 7th Semester)			**75+54=129**	**75+162=237**
Theory vs Practical with respect to Contact Hours			Theory Practical	75 (31.65%) 162 (68.35%)

6. Course Codes

Details pertinent to course codes 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-codes are defined in table below:

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

Letters in course-code prefix are defined below:

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

Course Code Examples		
Sr.	**Course Code Prefix**	**Description**
1	BI**T**	Biomedical Engineering Technology Foundation/ Breadth/ Depth
2	BI**E**	Expository Writing
3	BI**H**	Art & Humanities
4	BI**S**	Social Sciences
5	BI**Q**	Quantitative Reasoning
6	BI**N**	Natural Sciences
7	BI**C**	Computing
8	BI**M**	Management Sciences
9	BI**I**	Inter Disciplinary Technology Elective

7. Elective Courses

The lists of elective courses – grouped across depth and breadth categories – are presented below, showing credit hours and weekly contact hours.

Elective Depth Courses				Weekly Contact Hrs. (Th+Lab)
Course Code	**Title**	**Knowledge Area**	**Credit Hrs.**	
BIT-412	Medical Image Processing	Depth Elective-I	2+1 or 3+0	2+3 or 3+0
BIT-413	Biotelemetry System	Depth Elective-II	2+1 or 3+0	2+3 or 3+0
BIT-414	Biomedical Signal Processing	Depth Elective-III	2+1 or 3+0	2+3 or 3+0
BIT-415	Medical Device Quality System and Standards	Depth Elective-IV	2+1 or 3+0	2+3 or 3+0
BIT-416	Medical Device Regulatory Affairs	Depth Elective-V	2+1 or 3+0	2+3 or 3+0
BIT-417	Power Electronics	Depth Elective-VI	2+1 or 3+0	2+3 or 3+0
BIT-418	Medical Robotics	Depth Elective-VII	2+1 or 3+0	2+3 or 3+0
BIT-419	Rehabilitation Techniques	Depth Elective- VIII	2+1 or 3+0	2+3 or 3+0
BIT-4110	Tissue Engineering Technology	Depth Elective-IX	2+1 or 3+0	2+3 or 3+0
BIT-4111	Drug Delivery Systems	Depth Elective-IX	2+1 or 3+0	2+3 or 3+0
BIT-4112	Artificial Intelligence	Depth Elective-IX	2+1 or 3+0	2+3 or 3+0
BIT-4113	Bioinformatics	Depth Elective-IX	2+1 or 3+0	2+3 or 3+0
BIT-4114	Hospital Information System	Depth Elective-IX	2+1 or 3+0	2+3 or 3+0

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 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 andthe International Engineering Alliance.

Course Content
8.1 Basic Biology

CODE & TITLE (BIN-111) **Basic Biology** **(For Pre-Engineering students)**	CREDIT & CONTACT HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Natural Sciences**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** biology of living organisms.	C-2	1
CLO-2	**Explain** the working principles of nucleic acids (DNA and RNA) with respect to human body.	C-2	2
CLO-3	**Use** basic laboratory equipment to analyze cell biology.	P-3	1

Course Outline for Theory

Biology: Major branches of biology: Three Domains of life. Prokaryotes and Eukaryotes. Chemistry of bio molecules including nucleic acids: lipids: carbohydrates and proteins and hormones: Shape of molecule and its function. Cell structure and division including mitosis and meiosis: Tour of the cells and its organelles. Central dogma of Molecular Biology: Chromosomes and DNA: genes: units of heredity: Genes & alleles. Mendel's laws of inheritance: multiple alleles: linkage and crossing over: sex determination: Viruses and Infectious diseases: Immune system: Recombinant DNA technology: Development and role of cytoplasm and nucleus in development.

Course Outline for Lab

1. Methodology of Autoclave for Sterilization
2. Observance of Cell division in Onion Root Tip
3. Identification of Carbohydrate Molisch Test
4. Benedicts Test
5. Iodine Test
6. Osazon Test
7. Identification of Proteins
8. Ninhydrin Test
9. Xanthoproteic Test
10. Isolation of Cholesterol from Egg Yolk
11. Protein Denaturation Test
12. Determination of Serum Creatinine
13. Chromatography
14. Open Ended Lab

Recommended Books

1. Biology A Global Approach, Campbell, Jane B. Reece, Pearson Education (Latest Edition)
2. Life, The Science of Biology, David E. Sadava and W H Freeman (Latest Edition)

Course Content
8.2 Basic Mathematics

CODE & TITLE (BIN-112) **Basic Mathematics** **(For Pre-Medical students)**	CREDIT & CONTACT HOURS (3+0) **48 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	**Apply** elementary knowledge of linear algebra to address mathematical problems.	C-3	1
CLO-2	**Solve** different mathematical problems using knowledge of calculus and analytical geometry.	C-3	2

Course Outline for Theory

Complex Numbers: Properties of complex numbers: Conjugates and modulus: Geometrical representation of complex numbers: Quadratic Equations & Cube Roots: Roots of a quadratic equation (real: distinct: equal and imaginary roots): Formation of quadratic equation when the roots are given: Cube Root of Unity: Properties of cube root of unity: Matrices: Properties: sum: difference and multiplication of matrices: Cramer's rule: Solution of linear equations of three unknowns: Determinants: Properties: addition: subtraction and multiplication of determinants: Sequence and series: Arithmetic progression: Standard forms of an arithmetic progression: Arithmetic means: Geometric progression: Standard forms of a geometric progression: Sum of Infinite geometric series: Geometric means: Harmonic progression: Harmonic means: Relation between H.M.: A.M. and G.M.: Binomial Expansion: Expansion of type $(a+b)^n$ for positive integer of 'n': Use of the general term and determine the middle term or terms of the expansion: Partial Fractions: Resolve into partial fractions: Proper and improper fraction: Functions: One-one function: Onto function: Even function: Odd function: Exponential function: Trigonometric function: Logarithmic function: Circular Measure: Understand the definition of radians and use the relationship between radians and degrees: Trigonometric Functions: Basic functions e.g. sine: cosine: tangent etc. relation between them: Trigonometric identities: sum and difference formulae: multiple angle formulae: Inverse functions: Differential Calculus: Basic concepts: limits: exponential functions: differentiation of exponents and trigonometric functions: Integral Calculus: Basic integration: rules of integration: integration of exponential and trigonometric functions: integration by parts: integration using substitution: Analytical Geometry: Lines: midpoint: equation of lines: angles and sections

Recommended Book

1. Precalculus: Mathematics for Calculus, James Stewart, Lothar Redline and Saleem Watson, Cengage Learning (Latest Edition)
2. Mathematics for A Levels,CGP Books (Latest Edition)

Course Content
8.3 Communication Skills

CODE & TITLE (BIH-111) **Communication Skills**	CREDIT & CONTACT HOURS (3+0) **48 Theory + 0 Lab**	KNOWLEDGE AREA/ DOMAIN **Humanities**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the importance of written and spoken communication.	A-3	10
CLO-2	**Add** value to communication as a team member.	A-3	9

Course Outline for Theory

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, A. J. Thomson and A. V. Martinet, Oxford University Press. (Latest Edition)
2. Practical English Grammar Exercises 1, 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, Khaled Mohamed Al Maskari, Wiley (Latest Edition)
4. Communication Skills for Engineers, Sunita Marshal and C. Muralikrishna (Latest Edition)
5. The Essentials of Technical Communication, Elizabeth Tebeaux and Sam Dragga, Oxford University Press (Latest Edition)
6. College Writing Skills, John Langan (Latest Edition)
7. Exploring the World of English, Saadat Ali Shah, Ilmi Kitab Khana (Latest Edition)

Course Content
8.4 Islamic Studies/Social Ethics

CODE & TITLE (BIH-112) (BIH-113) **Islamic Studies/Social Ethics**	CREDIT & CONTACT HOURS (3+0) **48 Theory + 0 Lab**	KNOWLEDGE AREA/ DOMAIN **Humanities**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the Holy Quran, Hadith, and the life of the Holy Prophet (Peace be upon Him).	C-2	8
CLO-2	**Demonstrate** the knowledge of sciences as described in the Holy Quran.	C-3	6

Course Outline for Theory

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 Hajjat-ul-Wida (last address of the Holy Prophet: Peace be upon him): Seeratun-Nabi (Peace be upon him).

Life of the 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 (HoqooqUllbad) with detail.

Importance of Knowledge in 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, Syed. Abul Hasan Ali Nadvi (Latest Edition)
2. An Introduction to Islam, Dr. Muhammad Hameedullah (Latest Edition)
3. What is Islam? Maulana Manzoor Nomani (Latest Edition)
4. Islamiat (A standard book for CSS), Prof. Dr. ArifNaseem (Latest Edition)
5. Islamiat for Students O levels, Farkhanda Noor Muhammad (Latest Edition)

Course Content
8.5 Applied Physics

CODE & TITLE (BIN-113) **Applied Physics**	CREDIT & CONTACT HOURS (3+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Natural Sciences**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Comprehend** the laws of physics related to electrostatics and construction of capacitors.	C-2	2
CLO-2	**Apply** knowledge of electromagnetism and construct inductors.	C-3	2
CLO-3	**Describe** basic laws of mechanics pertaining to force and motion.	C-2	1
CLO-4	**Trace** basic principles used in mechanics, electrostatics and electromagnetism using the available laboratory equipment.	P-3	2

Course Outline for Theory

Electric charge: Conductors and insulators: Coulomb's law: Electric field: Field due to a point-charge Electric dipole and line of charge: Flux of an electric field: Permittivity of a medium: Gauss's law: Application of Gauss's Law:
Electric potential: calculating the potential from electric field: Potential due to a point-charge and a group of point-charges. Potential due to a dipole: Potential due to a continuous charge distribution:
Capacitors: calculating capacitance: Capacitors in series and parallel: Factors affecting capacitance: Application of Capacitors:
Current and Conductors: Electric current and current density: Resistance and resistivity: Ohm's law: The Steady Magnetic Field: Resistors in series and parallel: Temperature dependence of resistance and other factors affecting resistance: Application of resistors: The magnetic field: Magnetic force on a current carrying conductor: Torque on a current-loop
Magnetic field due to current: Force between two parallel current-carrying conductors: Biot Savart law and its applications: Ampere's law: Inductance and inductors: Factors affecting inductance Permeability Faraday's law of induction: Lenz's law: Energy stored in a magnetic field: Self-induction: Mutual Induction: Magnets and magnetic materials: Di-magnetic material: Para-magnetic material: Ferromagnetism. Concepts of Rest and motion: Force and friction: Work Energy and power: Momentum and law of conservation of momentum.

Course Outline for Lab

1. To investigate the properties of series combination of Capacitors
2. To determine the given resistance by leakage method using ballistic Galvanometer
3. To study the variation of Photoelectric current with intensity of incident beam
4. To determine the temperature coefficient of resistance of coil by wheat stone bridge
5. To study Ohm's law
6. To investigate the properties of Series Combination of Resistances
7. To investigate the properties of Parallel combination of Resistances
8. Practical Demonstration of Ampere Law
9. Practical Demonstration of Faraday Law
10. To demonstrate the function of transformer as Step Up and Step-Down Transformer

Recommended Books
1. Halliday, Resnick and Walker, “Fundamentals of Physics” (Latest Edition) 2. Hugh D. Young and R.A. Freedman, University Physics. (Latest Edition) 3. Raymond A Serway and John W. Jawett, Jr. Physics for Scientists and Engineers with modern Physics, (Latest Edition) 4. Fundamentals of Electromagnetic Phenomenon by D. Corson & Lorrain. (Latest Edition)

Course Content
8.6 Information and Communication Technology

CODE & TITLE (BIC-111) **Information and Communication Technology**	**CREDIT & CONTACT HOURS** (1+1) **16 Theory +48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Computing**	
After course completion students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** major components of computer hardware and software.	C-2	1
CLO-2	**Demonstrate** the concepts of data communication and networks.	C-3	1
CLO-3	**Demonstrate** the working of hardware components of computer.	P-4	1
CLO-4	**Practice** MS Office applications.	P-3	1

Course Outline for Theory

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

Course Outline for Lab

1. Introduction to the basics of the internet e.g., using search engines, using Wikipedia, checking your Email.
2. Personal computer components, inside the CPU.
3. Introduction to typing tutors, typing practice. Introduction to MS word.
4. Introduction to MS Power point.
5. Introduction to MS Excel.
6. Introduction to HTML
7. Introduction to HTML codes.
8. Writing small HTML codes.
9. Introduction to web designing.
10. Introduction to web designing (cont.)
11. Introduction to programming languages.
12. Introduction to programming languages (cont.)

Recommended Books
1. "Introduction to Computers", Peter Norton, McGraw-Hill (Latest Edition) 2. "Computing Essentials", Timothy O'Leary and Linda O'Leary, McGraw-Hill (Latest Edition) 3. Using Information Technology: A Practical Introduction to Computers & Communications", Williams Sawyer, McGraw-Hill (Latest Edition) 4. "Discovering Computers, Complete: Your Interactive Guide to the Digital World. Cengage Learning" Shelly GB, Vermaat ME (Latest Edition)

Course Content
8.7 Workshop Practices

CODE & TITLE (BIT-111) Workshop Practices	CREDIT & CONTACT HOURS (0+1) 0 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Foundation	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Use** safety equipment during workshop practice.	P-3	7
CLO-2	**Participate** in workshop activities individually as well as in a group.	A-2	9

Course Outline for Lab

1. Practicing the carpenter's tools
2. Analysis of preparing simple joints, and Bench fitting practice
3. Exercise in marking and fittings
4. Application of Smith's forge
5. Exercise in bending, Upsetting, and swaging
6. Various technical facilities in the workshop including mechanical and electrical equipment Concepts in electrical safety
7. Safety regulations and Earthing concepts
8. Electric shocks, and treatment
9. Use of tools used by electricians
10. Wiring regulations
11. Types of cables and electric accessories including switches plugs, circuit breakers, fuses etc., symbols for electrical wiring schematics e.g., switches, lamps, sockets etc.
12. Drawing and practice in simple house wring and testing methods
13. Wiring schemes of two-way and three-way circuits and ringing circuits
14. Voltage and current measurements
15. Electric soldering and soldering tools, Soldering methods and skills
16. PCB designing, transferring a circuit to PCB, Etching, Drilling, and soldering component on PCB testing.

Recommended Books

1. S. K. Choudhury, "Elements of Workshop Technology", (Latest edition)
2. Chapman, "Workshop Technology", (Latest edition)

Course Content
8.8 Technical Drawing

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN	
(BIT-112) **Technical Drawing**	(0+1) **0 Theory + 48 Lab**	**Computing**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Recognize** basic tools and shapes of Engineering Drawing.	C-1	1
LO-2	**Understand** basic principles of Engineering Drawing Tools for representation of Engineering Drawing Models.	C-2	1
CLO-3	**Practice** Engineering Drawing Principles to draw 2-D & 3D sketches using modern tools.	P-3	5

Course Outline for Lab

Mechanical Drawing: Sheet Layout: free hand sketching: basic drafting techniques: drawing and lettering: dimensioning: projections and section of solids: practice of assembly drawing. Civil drawing: plan: elevations (front left and right)

Electrical Drawing: Electrical safety drawings: electric substation equipment layout: schematic diagrams of substations: lighting and power distribution boards in contrast with house and industrial wiring diagrams: electrical symbols and one-line diagrams of a typical power system and its parts using all details: 2D modelling using AutoCAD: Layering using AutoCAD: 3D Wireframe Modelling in AutoCAD: 3D Solid modelling in AutoCAD: Helical Spring using AutoCAD: 3D Surface Modeling: Open Ended Lab

Recommended Books

1. Mitchel & Spencer, "Technical Drawing" (Latest Edition)
2. Choudhry, "Elements of Workshop Technology" Volume –I. (Latest Edition)
3. Chapman, "Workshop technology" Part-I, II, & III. (Latest Edition)

Course Content
8.9 Calculus and Analytical Geometry

CODE & TITLE (BIN-121) Calculus and Analytical Geometry	CREDIT & CONTACT HOURS (3+0) 48 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	**Discuss** basic equations, graphical sketches of different functions, limits, and continuity.	C-3	1
CLO-2	**Solve** problems by applying techniques of differentiation and integration.	C-3	2
CLO-3	**Analyze** vector calculus and analytical geometry in multiple dimensions for the investigation of different engineering technology problems.	C-4	4

Course Outline for Theory

Basics: Basic definition of derivative: differentiation of different function: rule of differentiation: chain rule implicit differentiation

Applications: slope: equation of tangent and normal, maxima, minima and point of inflection

Integration: Indefinite integral: different techniques of integration i.e., integration by parts: integration by substitution: by partial fraction: integration of different trigonometric identity

Definite integrals: 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 centre of mass etc.

Vector Spaces: Vector in space: vector calculus: Divergence: curl of vector field: Directional derivatives: multivariable function Partial derivatives: Spherical: polar: cylindrical coordinates

Vectors in Planes: 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. Calculus, G. B. Thomas, A. R. Finney, Pearson Education (Latest Edition)
2. Calculus, Early Transcendental, H Anton, I C Bivens and S Davis, John Wiley (Latest Edition)
3. Essential Calculus, James Stewart (Latest Edition)
4. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley (Lated Edition).

Course Content
8.10 Basic Electrical Technology

CODE & TITLE (BIT-121) Basic Electrical Technology	CREDIT & CONTACT HOURS (2+1) 32 Theory + 48 Lab	KNOWLEDGE AREA/DOMAIN Foundation	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** the concepts of fundamental electrical quantities, electromagnetism, and electrostatics.	C-1	1
CLO-2	**Describe** the relationship between line and phase voltage, and relationship between line and phase current in three-phase circuits of star and delta connections.	C-2	1
CLO-3	**Demonstrate** the construction, working & applications of electrical machines.	C-3	2
CLO-4	**Operate** AC/DC machines to determine various characteristics.	P-3	2
CLO-5	**Appropriately** exhibit the practical findings.	A-3	10

Course Outline for Theory

Basic Concepts: Series and parallel circuits: Independent and Dependent Sources: power: energy: inductance: magnetic circuits: Faraday's laws of electromagnetic induction: Fleming's right-hand rule: Lenz's law: capacitance: capacitance in series & parallel circuits: types: charging and discharging of capacitors.

A.C Fundamentals: Generation of alternating current and voltage: equations of alternating current and voltage: wave form: cycle: time-period: frequency: amplitude: phase: phase difference: root mean square (RMS) value: average value: form factor: power factor: Star and Delta connections: Instantaneous and Average Power Complex Power: Maximum Power Transfer: Power Factor.

DC Machines: Constructional details: principle of operation: back e.m.f: production of torque: types: characteristics: applications: methods of speed control.

AC Machines: Single – phase machines: types: characteristics and applications: three – phase machines: constructional details: production of torque: speed control.

Transformer: Constructional details: principle of operation: e.m.f equation: phasor diagrams on no-load/on-load: equivalent circuit: regulation: losses and efficiency; open circuit and short circuit tests: auto transformers: instrument transformers.

Course Outline for Lab

1. Ohm's law verification.
2. RMS, average and peak values of periodic waveforms using the oscilloscope.
3. Star and delta connections, relationship between line voltage and phase voltage/ line current and phase current in the three- phase star and delta connections.
4. Load test on D.C shunt/compound generators.
5. Open circuit characteristics of D.C generator.
6. Speed/torque characteristics of D.C motors.
7. Load test on single phase induction motor.
8. Efficiency of a single – phase transformer.
9. Effect of field excitation on generation of voltage by a generator.
10. Voltage regulation of three – phase generator.

Recommended Books
1. B.L.Theraja, A.K.Theraja - A text book of Electrical Technology, Vol. 2, S. Chand & Co. (Latest Edition)
2. Edward-Hughes- Electrical Technology. (Latest Edition)
3. Mehta V.K- Principles of Electrical Engineering and Electronics, S.Chand& Co. (Latest Edition)
4. Partab - Art and Science of Utilization of Electric Energy: Dhanpath Rai & Sons. (Latest Edition)

Course Content
8.11 Human Anatomy & Physiology

CODE & TITLE (BIT-122) **Human Anatomy & Physiology**	**CREDIT & CONTACT HOURS** (3+1) **48 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Foundation**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** basic cells tissue and organ of the human body system.	C-1	1
CLO-2	**Explain** the relationships among the bones, muscles, joints, and tissues.	C-2	1
CLO-3	**Illustrate** the respiratory system, cardiovascular system, alimentary system, and urinary system.	C-3	2
CLO-4	**Work** on different laboratory machines (BP apparatus: Sphygmomanometer, Hematology analyzers, ECG machine).	P-3	4
CLO-5	**Document** practical findings in form of reports.	A-3	10

Course Outline for Theory

Cell: Tissue: Organ: Organelles: Organ System: Basic Cell Structure: Plasma: The Blood Cell: Pressure: Flow And Resistance: Heartbeat Coordination: Mechanical Events of the Cardiac Cycle: The Cardiac Output: Measurement of Cardiac Function: Connective Tissue: Bones: Muscle and Joints (Structure & Types) Basic Anatomy and Physiology of Skeletal System: Nervous System: Respiratory System: Cardiovascular System: Digestive System and Urinary System. Homeostatic Mechanisms and Cellular Communication: Sensory and Neural Control Mechanism (Basic). Hormonal functions in Man and Women.

Course Outline for Lab

a. Safety precaution in performance and operation of Basic Medical laboratory Apparatus
b. Examining the basic Histological slides (Cell, Tissue)
c. Analysis of blood samples (CBC, Hemoglobin (Hb), WBC.)
d. Examination of Bleeding Time, Coagulation Time, and Blood groups
e. Determination of Tidal volume and Demonstration of Artificial Respiration
f. Recording of Arterial Pulse, Recording of Arterial Blood Pressure and Electro-cardiogram
g. Isolation and separation of blood components through Centrifuge machine

Recommended Books

1. Snell, "Clinical Anatomy for Medical Students" (Latest Edition)
2. Gerard J. Tortora, Principles of Anatomy and Physiology, (Latest Edition)
3. Ellis, horlad , Clinical Anatomy, A Revision and applied Anatomy for Clinical Students (Latest Edition)
4. Frederic H Martini Human Anatomy, et al. (Latest Edition)

Course Content
8.12 Computer Programming

CODE & TITLE (BIC-121) Computer Programming	CREDIT & CONTACT HOURS (1+1) 16 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Computing	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Apply** knowledge of programming language to solve real-world problems effectively.	C-3	1
CLO-2	**Write** and compile computer programs and troubleshoot for errors.	P-4	2

Course Outline for Theory

Introduction to the course, C/C++/Java/Python and their IDEs (the DAI can teach any of these languages), Data types and operators, Functions, Conditions (if, if-else, nested if-else), Conditions (switch statement, conditional operator),Recursion, Iteration (for loop, while, do-while), Iteration (do-while), Strings, File handling, Structures, Arrays, Sorting and their big O analysis, Array and passing arrays to functions.

Course Outline for Lab

1. Introduction to a programming language (C/C++/Java/Python)
2. Arithmetic operations
3. Conditional statements
4. Repetitive statements/loops
5. Functions
6. Recursion
7. Arrays- one dimensional
8. Sorting algorithms
9. Arrays – 2 dimensional
10. Strings
11. Graphical User Interfaces (GUIs)
12. Object Oriented Programming (OOP)
13. Open ended Lab(s)

Recommended Books

1. Python crash course: A hands-on, project-based introduction to programming, Matthes, Eric, No Starch Press (Latest Edition)
2. Learning python: Powerful object-oriented programming, Lutz, Mark, O'Reilly Media Inc. (Latest Edition)
3. C++ How to Program, Deitel & Deitel, Prentice Hall (Latest Edition)
4. Problem Solving with C++, Walter Savitch, Addison Wesley (Latest Edition)
5. Java, Paul J Deitel and Harvey M Deitel, Pearson Press (Latest Edition)

Course Content
8.13 Management Sciences Elective-I

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(BIM-121) **Management Sciences Elective-I**	(3+0) **48 Theory + 0 Lab**	**Management Sciences**

The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of elective courses defined in this Curriculum. The HEI must ensure adequacy of academic and other resources for the course.

Course Content
8.14 Social Sciences Elective-I

CODE & TITLE	CREDITS HOURS	KNOWLEDGE AREA/DOMAIN
(BIS-121) **Social Sciences Elective-I**	(3+0) **48 Theory + 0 Lab**	**Social Sciences**

The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of elective courses defined in this Curriculum. The HEI must ensure adequacy of academic and other resources for the course.

Course Content
8.15 Biochemistry

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(BIN-211) **Biochemistry**	(2+1) **32 Theory + 48 Lab**	**Natural Sciences Forced Electives**

After completion of this course, students will be able to:		Bloom's Taxonomy Level	PLO
CLO-1	**Comprehend** knowledge of biochemistry and macro-molecules.	C-1	1
CLO-2	**Compare** metabolic pathways for diagnosis of metabolites in human body.	C-4	2
CLO-3	**Investigate** the structure and activity of biomolecules at cellular level.	C-4	4
CLO-4	**Conduct** experiments for the detection of biomolecules.	P-3	2
CLO-5	**Demonstrate** amino acid separation using chromatographic methods.	P-4	1

Course Outline for Theory

Introduction to Biochemistry: Colloidal state, buffer, pH, significance of pH Henderson equation, surface tension, viscosity, osmosis, diffusion, Biological Membrane and chromatographic techniques (TLC, Paper, HPLC)
Carbohydrates, their metabolism and energy cycles (Glycolysis, gluconeogenisisetc), Lipids, types and their metabolism and Proteins, Amino acids and their metabolism.
Bioenergetics: DNA & RNA and role of ATP for biological energy transfer, thermodynamics of life, Micromolecules and traces elements.

Course Outline for Lab
1. Preparation of solution in laboratory 2. Determination of pH by pH meter and Litmus paper 3. Demonstration the action of buffer 4. To determine the principal application of Hander son- Haselbash's equation 5. Tests for proteins 6. Examination of egg white 7. Color reactions for proteins 8. Isolation of Casein from milk 9. Tests on carbohydrates 10. Measurement of Blood Glucose level with help of spectrophotometer 11. Oral Glucose Tolerance Test (OGTT) 12. Tests of Lipid profile by chemical analyzer 13. Separation of Amino Acids by chromatographic methods. 14. Open Ended Lab I 15. Open Ended Lab II 16. Open Ended Lab III
Recommended Books
1. Biochemistry (Lippincott's illustrated reviews series), Richard A Harvey and Denise R Ferrier (Latest Edition) 2. Modern experimental biochemistry, Boyer, Rodney, Pearson Education, (Latest Edition) 3. Principles of Biochemistry, Lehninger, W.H Freeman and Co, (Latest Edition) 4. Fundamentals of Biochemistry, Donald Voet and Judith G. Voet,, (Latest Edition)

Course Content
8.16 Linear Algebra & Differential Equations

CODE & TITLE (BIN-212) Linear Algebra & Differential Equations	CREDIT & CONTACT HOURS (3+0) 48 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	**Describe** various operations on matrices to solve systems of linear equations.	C-2	1
CLO-2	**Apply** linear transformations and matrix theory to model real-life situations.	C-3	1
CLO-3	**Describe** differential equations, solutions of first and higher orders, homogeneous and non-homogeneous differential equations by appropriate methods.	C-2	2
CLO-4	**Apply** basic concepts of linear algebra and differential equations to solve elementary electrical, mechanical, and thermal engineering technology problems.	C-3	2

Course Outline for Theory

System of linear equations: row reduction and echelon forms: vector equations: the linear matrix equation. 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 graphics etc.

Basic concept of differential equation: i.e.: Definition: order: degree: and geometric meaning of differential equation. Solution of First order Differential Equations: Separable equations: Exact Differential Equation: integrating Factor: Linear Ordinary Differential Equations (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 Differential Equations. Finding Laplace and inverse Laplace of different functions: S- shifting 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, Erwin Kreyszig, Wiley (Latest Edition)
2. Introductory Linear Algebra, Bernard Kolman (Latest Edition)
3. Linear Algebra and its Applications, Gilbert Strang (Latest Edition)
4. Linear Algebra and Its Applications, D C Lay, S R Lay and J J McDonald, Pearson Education (Latest Edition)

Course Content
8.17 Electrical Circuit Analysis

CODE & TITLE (BIT-211) Electrical Circuit Analysis	CREDIT & CONTACT HOURS (2+1) 32 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Foundation	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the concepts of electric circuits with DC & AC sources.	C-2	1
CLO-2	**Analyze** the transient and steady-state response of 1st order and 2nd order electric circuits .	C-4	2
CLO-3	**Understand** and implement circuits in the S-domain.	C-3	2
CLO-4	**Demonstrate** knowledge of constructing electric circuits using hardware or software.	P-2	5
CLO-5	**Exhibit** practical findings in form of reports.	A-3	10

Course Outline for Theory

Basic Concept: Electric charge: current: voltage: power: energy: and sources; circuit elements- resistor: inductor and capacitor. Series and parallel combination of circuit elements. Circuit Laws and Rules: Ohm's law: Kirchhoff's laws: voltage divider rule and current divider rule. Analysis Methods: Nodal analysis: mesh analysis: source transformation: linearity and superposition: maximum power transfer theorem. RL: RC (1st order) Circuits: Natural and step response. RLC (2nd order) Circuits: Natural and step response. Sinusoidal Steady-State Analysis: Average and RMS values of signals: the phasor: admittance: impedance: AC analysis methods: resonance: and matching: power in AC circuits: inductive coupling and transformers. Laplace Transform; Step and impulse functions: applying Laplace transform: poles and zeros: circuit analysis in S-domain: transfer functions: frequency response and bode plots.

Course Outline for Lab

1. Use of basic instruments in electrical circuit analysis i.e., function generators power supplies, oscilloscopes, etc.
2. Design and implement different electrical circuits using different laws.
3. Verify circuit transformations using lab instruments.
4. Use software to simulate and analyze circuits.

Recommended Books

1. W Hayt, J Kemmerly and S Durbin, "Engineering Circuit Analysis", McGraw- Hill, (Latest Edition).
2. Nilsson and Riedel, "Electric Circuits", (Latest Edition).
3. Robert L. Boylestad, "Introductory Circuit Analysis", (Latest Edition).
4. C Alexander and M Sadiku, "Fundamentals of Electric Circuits", McGraw- Hill, (Latest Edition)
5. J D Irwin and R M Nelms, "Basic Engineering Circuit Analysis", Wiley,(Latest Edition)
6. R E Thomas, A J Rosa and G J Toussaint, "The Analysis and Design of Linear Circuits", John Wiley, (Latest |Edition)

Course Content
8.18 Digital Logic Design

CODE & TITLE (BIT-212) Digital Logic Design	CREDIT & CONTACT HOURS (2+1) 32 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Breath	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** fundamental concepts used in 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). Field programmable gate arrays.

Course Outline for Lab

1. To study basic logic gates and their functions
2. To design a half adder circuit
3. To design a full adder circuit
4. To design and implement 4-bit adder using logic gate ICs
5. To design and implement 4-bit subtractor using logic gate ICs
6. To analyze the operation of BCD to 7-segment decoder
7. To design a synchronous and asynchronous counter using J K flip flops
8. To design combinational circuits using multiplexer and demultiplexer
9. 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
11. To design and implement 8 bits added on FPGA
12. To design and implement BCD to seven segment decoders on FPGA
13. Design and implement 8-bit counter with synchronous reset and load functionality on FPGA.

Recommended Books

1. Morris Mano and Charles R. Kime, "Logic and Computer Design Fundamentals", Prentice Hall
2. Tocci and Widmer, "Digital Systems: Principles and Applications"

Course Content
8.19 Social Sciences Elective-II

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/DOMAIN
(BIS-211) **Social Sciences Elective-II**	(3+0) **48 Theory + 0 Lab**	**Social Sciences**

The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of elective courses defined in this Curriculum. The HEI must ensure adequacy of academic and other resources for the course.

Course Content
8.20 Signals and Systems

CODE & TITLE	CREDIT HOURS	KNOWLEDGE AREA/DOMAIN
(BIT-221) **Signals and Systems**	(2+1) **32 Theory + 48 Lab**	**Breadth**

After completion of this course, students will be able to:		Bloom's Taxonomy Level	PLO
CLO -1	**Apply** operations on signals like shifting, time-reversal, convolution, and scaling.	C-3	1
CLO-2	**Analyze** signals and systems in frequency domain.	C-3	2
CLO-3	**Investigate** stability and causality of systems described by differential equations/difference equations using methods such as Z-transform.	C-4	4
CLO-4	**Perform** experiments related to analysis of signals and systems.	P-3	5
CLO-5	**Operate** proficiently MATLAB/Python to perform tasks such as: matrix manipulation, generating and plotting, load/save data, small programs.	P-4	5

Course Outline for Theory

Basic Signals: unit impulse sequence, step sequence, complex exponential sequence. Signal operations include time-shifting, scaling, time-reversal. System properties include linearity, causality, time-invariance, and stability. Implementation of discrete time-systems using convolution expression. Spectral representation of periodic and aperiodic signals using Fourier series and Fourier transform. Frequency response of an LTI system. Transformation techniques for signals. Analysis of stability and causality of discrete-time systems characterized by difference equations. Understanding of tradeoffs involved in the design of FIR and IIR filters and design of digital filters in MATLAB/Python. Overview of basic biomedical signals like ECG, EEG, EMG.

Course Outline for Lab

1. Introduction to MATLAB/Python
2. Writing programs using conditional statements, loops and efficient implementation using vectorization of code
3. Plotting signals
4. Basic Signal Generation
5. Symbolic toolbox for performing integration, differentiation, Fourier transform computation.
6. Implementing LTI system using difference equation/convolution operation
7. Transformation techniques

8. Frequency domain analysis of signals
9. Frequency domain analysis of systems
10. Filter design
11. Open Ended Lab

Recommended Books

1. Signal Processing First, James H. McClellan, Ronald Schafer, and Mark Yoder. Latest Edition, Pearson
2. A Oppenheim, A Willsky and H Nawab, “Signals and Systems” Pearson, Latest Edition
3. Simon Haykin and Barry Van Veen, “Signals and Systems” Wiley, Latest Edition

Course Content
8.21 Electronic Devices and Circuits

CODE & TITLE (BIT-222) Electronic Devices and Circuits	CREDIT & CONTACT HOURS (2+1) 32 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Foundation	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Apply** the concept of semiconductor diode and use it for various applications to solve circuits.	C-3	1
CLO-2	**Analyze** the working principles and characteristics of the different transistors for various source configurations and biasing techniques.	C-4	2
CLO-3	**Demonstrate** and analyze different electronic circuits and practice transistor's operations to achieve desired outputs.	P-4	4
CLO-4	**Perform** the lab task in a group team environment with minimal direction of instructor.	A-2	9

Course Outline for Theory

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 Transistors: its configurations 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.

Course Outline for Lab

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

Recommended Books

1. Electronic Devices and Circuit Theory, H. Boylestad and L. Nashelsky, (Latest Edition)
2. Electronic Devices, Thomas L. Floyd, (Latest Edition)
3. Electronics Principles, Alberto P Malvino(Latest Edition)
4. Electrical Technology By B.L Theraja and A.K Theraja(Latest Edition)
5. Theodore F. Bogart, Jeffrey S. Beasley, Guillermo Rico, "Electronic devices and circuits", (Latest Edition)

Course Content
8.22 Microprocessors and Microcontrollers

CODE & TITLE (BIT-223) Microprocessors and Microcontrollers	CREDIT & CONTACT HOURS (2+1) 32 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Depth	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** basic knowledge, features, and operation of contemporary microcontroller and microprocessor.	C2	1
CLO-2	**Explain** different internal architectures and applications of Microprocessor and Microcontroller.	C2	1
CLO-3	**Apply** assembly language programming to analyze different blocks of the Microprocessor/Microcontroller.	C3	2
CLO-4	**Imitate** experiments using development kits, ICs and simulation software.	P2	5
CLO-5	**Reproduce** the skills of Programming Arduino processor in C++.	P2	5

Course Outline for Theory

Introduction to Intel family microprocessors/microcontrollers, instruction set architecture (ISA). Assembly language programming, hardware model, read/write cycles, exception/interrupt processing, I/O devices, DMA, interfacing to memory and I/O devices. Introduction to PIC/Atmel 8051. Introduction to microcontrollers; architecture and programming, Arithmetic Instructions, Logic Instructions, Program Control Instructions, Introduction to Interrupts

Course Outline for Lab

1. Introduction to development kit of any microcontroller
2. Development of different applications on microcontroller kit.
3. Learn to read datasheets/manuals in order to develop practical applications.
4. Assembly and C language-based microcontroller (PIC or Raspberry Pi)
5. Interfacing for interrupt and data-based applications involving LED/ LCD, GPIO ports, communication ports, A/D, and D/A interfacing.
6. Project can be input voltage-based speed control of DC Motor / stepper motor using PWM

Recommended Books

1. Douglas V. Hall, "Microprocessor and Interfacing", Tata McGraw-Hill. (Latest edition)
1. 8051 Microcontroller and Embedded Systems, M. Ali Mazidi, J. Mazidi and R. McKinlay, Prentice Hall, ISBN: 013119402X (Latest Edition)
2. The Intel Microprocessors Architecture, Programming & Interfacing, Barry B. Brey (Latest Edition)
3. Microprocessor and Interfacing, Douglas V. Hall, Tata McGraw-Hill, ISBN: 0070601674 (Latest Edition)
4. PIC Microcontroller: An Introduction to Software & Hardware Interfacing, Han-Way Huang, T. Delmar Learning, ISBN: 1401839673 (Latest Edition)

Course Content
8.23 Biomechanics

CODE & TITLE (BIT-224) Biomechanics	CREDIT & CONTACT HOURS (2+1) 32 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Breadth	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the basic knowledge of moving system mechanics with an overview of anatomical terminology, to understand gross human movements.	C-2	1
CLO-2	**Apply** the knowledge of human biomechanics to provide solutions to case studies for specific body segments.	C-3	2
CLO-3	**Perform** experiments under supervision related the kinematics and kinetics of upper and lower limb using hardware and software.	P-3	5
CLO-4	**Communicate** the results of the experiment effectively in written and oral form.	A-2	10

Course Outline for Theory

Definition and perspective: Review of statics: Review of Dynamics: Review of deformable body mechanics: Viscoelasticity: material properties. Density: mass: and inertial properties: Direct measurement of anthropometric parameters: Muscle anthropometry: Mechanical advantage of muscle: Multipoint muscles. Forms of motion: Standard reference systems and joint movement terminology: Spatial reference systems: qualitative vs. quantitative analysis of human movement: limb-segment angles: joint angle: linear and angular velocities: and acceleration: Tools for direct/indirect measurement of kinematic quantities. Link segment models: Internal and external forces acting on the link-segment model: Joint reaction forces: Direct Force measurements. Composition and structure of bone tissue: Material constituents: Structural organization: Types of bones: Bone growth and development: Bone response to stress: Osteoporosis. Joint architecture: stability: and flexibility: common joint injuries: and pathologies. Behavioral properties of musculotendinous unit: Structural organization of skeletal muscle and its function: Muscular force: strength: power: and endurance: Common muscle injuries. Structure: movement and loads of shoulder: elbow: and wrist: Common injuries of upper limb. Structure: movement and loads of hip: knee: ankle: and foot: Common injuries of lower limb**.** Structure: movement and loading of spine: Common injuries of back and neck. Methods of gait analysis: Gait cycle: Temporal-spatial parameters: Hip: knee and ankle joint kinematics and kinetics: Interpretation of gait data

Course Outline for Lab

1. To observe the human skeletal joints and their movement in anatomical reference planes.
2. To demonstrate the use of various methods of solving vectors problems in biomechanical analysis
3. To investigate the kinetics involved in different types of motion
4. To determine the coordinates of the center of gravity (COG) of a body using segmentation method
5. To understand the nature of torque and its effects on the body.
6. To determine the muscle force required by the biceps while holding a known weight in hand for a range of elbow joint angles using the mechanical arm model.
7. To estimate the biomechanical power of an individual using the Sargent Jump test
8. To study and test the biomechanical power of an individual using the Vertical Jump test via Jump Mat
9. To study and investigate the gait cycle mechanism and collect data on the temporal-spatial parameters of gait for a range of

anatomically intact individuals

10. To assess the joint flexibility (ROM) and effects of fatigue on ROM using a simple mechanical Goniometer
11. To investigate and plot the movement of ideal and practical biomechanical elbow model using MATLAB
12. To calculate the lower limb joint angles, joint angular velocity and joint power using raw coordinate data
13. Open Ended Lab

Recommended Books

1. Basic Biomechanics, Susan J. Hall (Latest Edition)
2. Biomechanics and Motor Control of Human Movement, David A. Winter, Latest Edition, Jhon Wiley & Sons (Latest Edition)

Course Content
8.24 Molecular Biology

CODE & TITLE (BIT-225) Molecular Biology	CREDIT & CONTACT HOURS (2+1) 32 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Breadth	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Gain** basic knowledge of gene structure and organization.	C-1	1
CLO-2	**Describe** the general principles of gene expression in both prokaryotic and eukaryotic organisms.	C-2	1
CLO-3	**Analyze** results that are obtained from different experiments.	P-3	4
CLO-4	**Communicate** results of experiments effectively in written and oral.	A-2	10

Course Outline for Theory

Review of biochemistry: organism classes: cellular structure: DNA: RNA: genes and proteins: prokaryotes and eukaryotes: Mendel's Law of Inheritance: The Cell Cycle; Mitosis & Apoptosis: Prokaryotic Polymerase: promoters: terminators: regulation: operations and control of transcription : RNA polymerases: Transcription Factors: Transcription activators: regulation of transcription factors: RNA Splicing: capping & polyadenylation: Ribosomal RNA processing: Transfer RNA processing: post transcriptional control of gene expression: Initiation: elongation and termination in prokaryotes and eukaryotes: ribosome and transfer RNA: Overview of replication: DNA damage & repair: homologous meiotic recombination: site specific recombination: transposition in prokaryotes and eukaryotes: Recombinant DNA technology: Polymerase Chain Reaction: Gel Electrophoresis: Chromatography: Labeled tracers DNA sequencing: Mapping transcripts: Molecular pathology of aging: cancer: gene therapy: Origin of life on Earth: Evolution of living organisms

Course Outline for Lab

1. To understand the structure and function of the microscope.
2. To visualize different stages of mitosis in different cells.
3. To examine the bacterial colonies.
4. To count Prokaryote Cell Number by Dilution Plating.
5. To prepare the specimens for molecular studies
6. To prepare cell pellet & understand lysis of cells
7. To understand phenol extraction & ethanol precipitation processes and ribonuclease treatment.
8. Extraction of muscle protein from animal tissues.
9. To perform protein gel electrophoresis
10. To explore the site map of NCBI and PUBMED and to study the resources available on NCBI and PUBMED.
11. To retrieve a nucleotide sequence of interest from Genbank entry
12. To search the unknown or similar sequence of given query using Basic Local Alignment Search Tool (BLAST).
13. Open ended lab

Recommended Books

1. Robert F. Weaver, Molecular Biology, Janice Roerig-Blong Publishers, (Latest Edition)
2. Stephen R. Bolsover, Jeremy S. Hyams, Elizabeth A. Shephard, Hugh A. White, Claudia G. Wiedemann, Cell Biology, John Wiley & Sons, Inc. Publications, (Latest Edition)

Course Content
8.25 Management Sciences Elective-II

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/DOMAIN
(BIM-221) **Management Sciences Elective-II**	(2+0) **32 Theory + 0 Lab**	**Management Sciences**

The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of elective courses defined in this Curriculum. The HEI must ensure adequacy of academic and other resources for the course.

Course Content
8.26 Biomaterials

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(BIT-311) **Biomaterials**	(2+1) **32 Theory + 48 Lab**	**Breadth**

After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Define** the fundamental concepts and principles of biomaterials, their types and structures, characteristics of biomaterials, material fabrication techniques and their testing.	C-1	1
CLO-2	**Analyze** various materials based on their performance.	C-2	2
CLO-3	**Apply** knowledge from basic concepts of materials to propose sustainable solution to existing problem.	C-3	7
CLO-4	**Participate** effectively in lab experiments individually or in small groups.	A-2	9
CLO-5	**Perform** experiments related to biomaterial and investigate the findings to achieve the desired results.	P-2	4

Course Outline for Theory

Historical development and impact of Biomaterials: Hard Tissues and Pathologies: Atomic molecular and crystal structure of solids: Crystalline and non-crystalline materials: Crystal imperfections: Metals: types: properties: and fabrications: Introduction to ceramics: structure: properties: surface reactive ceramics and analysis of ceramics surfaces: Polymers: types: properties: and applications: Composites: Anisotropy: particulates: fibrous and porous materials: Corrosion and Deterioration of Materials: Biological testing: Performance of implants: Safety and efficacy testing:

Course Outline for Lab

1. To study methods of sample sectioning
2. To study methods of mounting
3. To study methods of grinding
4. To study methods of polishing
5. To study method of etching
6. To study different microscopic techniques used in metallographic analysis
7. To study the degradation behavior in acid and basic media
8. To study the degradation behavior in biological fluids

9. To do the hardness testing of various biomaterials
10. To do the tensile testing of biomaterial
11. To study the densification and heat treatment of bio ceramics
12. Open-ended labs

Recommended Books

1. Michael N. Helmus, Biomaterials in the Design and Reliability of Medical Devices (Latest Edition)
2. David Hill, Design Engineering of Biomaterials for Medical Devices (Latest Edition)
3. Buddy D. Ratner, et al, Biomaterials Science, Second Edition: An Introduction to Materials in Medicine (Latest Edition)
4. Kay C. Dee, et al, An Introduction to Tissue-Biomaterial Interactions (Latest Edition)
5. Rolando Barbucci, Integrated Biomaterials Science (Latest Edition)
6. Materials Science and Engineering: An Introduction, William D. Callister, Jr., David G. Rethwisch (Latest Edition)
7. Biomaterials Science: An Introduction to Materials in Medicine, Edited by Buddy D. Ratner (Latest Edition)
8. Biomaterials Principles and Application, Joon B. Park, Joseph D. Bronzino (Latest Edition)

Course Content
8.27 Biomedical Instrumentation

CODE & TITLE (BIT-312) Biomedical Instrumentation	CREDIT & CONTACT HOURS (2+1) 48 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Breadth	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO -1	**Explain** the basic concepts related to the classification techniques and working principles of biomedical equipment.	C-2	1
CLO-2	**Demonstrate** the use of sensors, transducers, and biopotentials for the design of biomedical applications.	C-3	2
CLO -3	**Design** operational prototypes using fundamental components for various biomedical applications.	C-5	3
CLO -4	**Imitate** electronics circuits with microcontroller interface.	P-3	5
CLO -5	**Participate** effectively in lab experiments individually or in small groups.	A-2	9

Course Outline for Theory

Various forms of bio signals (bioelectric: bio optic: biochemical: biomechanical: bioacoustics): Active and passive transducers: displacement sensors: inductive and capacitive sensors: piezoelectric sensors: temperature sensors: optical sensors: radiation sensors: electro-chemical sensors: bio sensors: fiber optics: Introduction to (medical) instrumentation: accuracy: sensitivity: reproducibility: biocompatibility: classification: measurement constraints: invasive & non-invasive techniques: design criteria: Different types of electrodes (EEG: ECG: EMG: ERG: MEG): Physiological effects of electricity: micro and macro shock hazards: electrical safety codes and standards: basic approaches for protection against shock: protection equipment design: electrical safety analyzers: testing the electric system: testing of electrical appliances. Cardiovascular Devices: Blood Pressure Devices: Pacemaker: Defibrillator: Pulmonary Function Analyzer: Spirometry: Pulse Oximetry: Nebulizer: Capnography: Anesthesia Machine: Ventilators: Heart Lung Machine: Hemodialysis Machine: Patient Monitors: Surgical Theater Devices

Course Outline for Lab

1. Introduction to Arduino and IDE
2. Interfacing LCD with Microcontroller
3. Interfacing Keypad with Microcontroller
4. Interfacing Ultrasonic sensor with Microcontroller
5. Interfacing Humidity and Temperature sensor with Microcontroller
6. Interfacing Flex sensor with Arduino
7. Interfacing Reed Switch with Arduino
8. Interfacing Magnetic Hall sensor with Microcontroller
9. Interfacing Rotary Encoder with Arduino
10. Interfacing Infrared Temperature sensor with Arduino
11. Interfacing Heart Rate sensor with Microcontroller
12. Interfacing Joystick with Arduino
13. Open ended lab-I
14. Open ended lab-II

Recommended Books
1. Medical Instrumentation: Application and Design; John Webster; Latest Edition; John Wiley & Sons (Latest Edition) 2. Introduction to Biomedical Engineering; John Enderle, Joseph Bronzino; Latest Edition, Academic Press (Latest Edition) 3. Introduction to Biomedical Equipment Technology; Joseph J. Carr, John M. Brown; Latest Edition; Pearson (Latest Edition) 4. Biomedical Instrumentation: Technology and Applications; Khandpur; Latest Edition; McGraw-Hill Education (Latest Edition)

Course Content
8.28 Biomedical Control Systems

CODE & TITLE (BIT-313) Biomedical Control Systems	CREDIT & CONTACT HOURS (2+1) 32 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Depth	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Analyze** the response and stability of a control system in time and frequency domains.	C-4	2
CLO-2	**Perform** simplification of the block diagrams and signal flow graphs for linear time invariant control systems.	C-3	1
CLO-3	**Develop**, test, debug and correct MATLAB programs using knowledge of control systems.	P-4	5
CLO-4	**Design** Proportional / Integral / Differential (or in combinations) controller for different closed loop applications.	P-5	3

Course Outline for Theory

Introduction to Control Systems: Open – loop and closed – loop systems and their transfer functions: block diagrams: signal flow graphs: Importance of modeling: Formation of differential equations of electrical: mechanical: electromechanical and other systems: Modeling of human systems: Poles and zeros of a transfer function: stability: standardized inputs: steady – state and transient response of first – order: second order and higher order systems: Transient response specifications in time and frequency domain: Introduction to state space concepts and terminology: formation of state and output equations for physical systems: Solution of state equations: Eigenvalues and Eigen vectors: state – transition and transfer function matrices: Types and analysis of feedback control systems based on steady-state error coefficients: sensitivity function: Root locus diagrams: Analysis and Design of Control Systems Based on Root locus technique: Routh-Herwitz Stability criterion: Bode plots: Polar plots: Nyquist stability criterion: Gain and phase margins: Nichol's chart:
Application of principles of control theory to analysis of biological system development of computer simulations techniques to study dynamic response of physiological system:

Course Outline for Lab

1. Using MATLAB for control systems
2. Modelling of physical systems, linear control system modelling
3. LTI Systems, First and Second Order system response
4. Computing Nyquist Criteria, root-locus and Bode plots
5. PI, PD and PID controllers
6. Servo motor control

Recommended Books

1. S.K. Bhattacharya, Control Systems Engineering (Latest Edition)
2. Norman Nice, Control Systems (Latest Edition)
3. B. Kuo, Automatic Control Systems. (Latest Edition)
4. D'Azzo Control System (Latest Edition)
5. Shaum Series. Feedback Control System (Latest Edition)

Course Content
8.29 Pakistan Studies

CODE & TITLE (BIH-311) Pakistan Studies	CREDIT & CONTACT HOURS (3+0) 48 Theory + 0 Lab	KNOWLEDGE AREA/ DOMAIN Humanities	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** various stages of Pakistan Movement inspired by the need of an ideological state.	C-2	8
CLO-2	**Analyze** amendments in the constitution of Pakistan made since 1973.	C-4	8
CLO-3	**Understand** current issues of Pakistan, their causes and solution.	A-4	8

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

Course Content
8.30 Technical Report Writing

CODE & TITLE (BIE-311) Technical Report Writing	CREDIT & CONTACT HOURS (2+0) 32 Theory + 0 Lab	KNOWLEDGE AREA/ DOMAIN Humanities	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Exhibit** basic academic and research-based writing skills.	A-2	10
CLO-2	**Demonstrate** formal communication skills, including business letters, CVs, and minutes of meetings.	A-4	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, Daniel Riordan (Latest Edition)
2. Technical Writing and Professional Communication, Leslie Olsen and Thomas Huckin (Latest Edition)
3. Communication for Engineering Students, J. W. Davies, (Latest Edition)
4. Science Research Writing for Non-Native Speakers of English, Hilary Glasman-Deal, Imperial College Press (Latest Edition)

Course Content **8.31 Project-I**			
CODE & TITLE (BIT-314) **Project-I**	**CREDIT & CONTACT HOURS** (0+3) **0 Theory + 144 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Project-I**	
After course completion students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Identify** and apply background knowledge of engineering technology fundamentals for implementation of project ideas and comparison with previous related research.	C-3	1
CLO-2	**Analyze** problem statements through research and literature review.	C-4	2
CLO-3	**Defend** the impact of proposed idea in societal and environmental contexts, and demonstrate its efficacy for sustainable development.	C-5	7
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 technology problems for improvement of society or environment.	A-4	6
CLO-6	**Practice** and adapt ethical values in various methods .	A-5	8
CLO-7	**Demonstrate** effectiveness as an individual as well as a team member.	A-4	9
CLO-8	**Display** communication skills through presentations, technical reports, and poster .	A-5	10
CLO-9	**Display** the results of hardware components testing.	P-5	5

Course Content
8.32 Medical Imaging Devices

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN	
(BIT-321) **Medical Imaging Devices**	(2+1) **32 Theory + 48 Lab**	**Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the fundamental concepts related to radiation physics involved in various diagnostic imaging modalities.	C-2	1
CLO-2	**Analyze** working and applications of various diagnostic medical imaging equipment.	C-4	2
CLO-3	**Troubleshoot** diagnostic radiological equipment.	P-4	4
CLO-4	**Read** different types of images from DICOM and test image and perform different spatial domain transformation and reconstruction of images in programming software.	P-2	5

Course Outline for Theory

Interaction of Radiation with Matter: Scattered & absorbed Radiation: spatial image formation. Imaging Transducers: Various transducers used in medical imaging systems. Imaging development: X-ray Film: Fluoroscopic imaging: Digital Imaging System: X-ray imaging: Film-less radiographic imaging: CT imaging: Emerging areas in medical imaging: Ultrasound Imaging: Medical imaging software: Algorithms: techniques: imaging archival and management: Molecular imaging and other advance biomedical imaging techniques and their image manipulation.

Course Outline for Lab

1. Demonstration of X-rays Equipment.
2. Demonstration of Ultrasound Equipment.
3. Introduction, Technicalities, MATLAB
4. Histograms and Morphological Operators on X-rays
5. Intensity Transformation using MATLAB
6. Spatial Filtrating using MATLAB of medical Images
7. Filtrating in frequency Domain of medical Images
8. Image restoration of Medical Images

Recommended Books

1. Bushberg J.T., The Essential Physics of Medical Imaging (Latest Edition)
2. Z. H. Cho, Foundations of Medical Imaging (Latest Edition)
3. Atamdhawan, Medical Image Analysis (Latest Edition)
4. Buxton, Richard B, Introduction to Functional Magnetic Resonance Imaging: Principles and Techniques (Latest Edition)
5. Murdy, Karen M., Biomedical Imaging (Principles & Application Engg: Series) (Latest Edition)
6. Andrew G. Webb, Introduction to Biomedical Imaging (IEEE Press Series on Biomedical Richard A. Robb, Engineering) Biomedical Imaging, Visualization, and Analysis (Latest Edition)
7. Karen M. Mudry et. al, Biomedical Imaging (Principles and Applications in Engineering) (Latest Edition)

Course Content
8.33 Probability & Statistics

CODE & TITLE	CREDIT & CONTACT HOURS	KNOWLEDGE AREA/ DOMAIN
(BIN-321) **Probability & Statistics**	(2+0) **32 Theory + 0 Lab**	**Natural Sciences**

After completion of this course, students will be able to:		Bloom's Taxonomy Level	PLO
CLO-1	**Discuss** fundamentals of graphical representation and frequency distributions.	C-2	2
CLO-2	**Apply** concepts of descriptive statistics to solve problems in the domain of Biomedical Engineering Technology.	C-3	3
CLO-3	**Compare** different types of data by exploiting their statistical characteristics using t-test, chi-square test and ANOVA to evaluate statistical significance.	C-4	2

Course Outline for Theory

Fundamentals of probability theory: Probability distribution and statistical characteristics of a random signal: Measures of central tendency and variation: Chebychev's theorem: z-scores: Frequency distributions: Graphical representation of data and Box plots: Symmetry: skewness and Quintiles (percentiles: deciles & Quartiles): Conditional probability and Bayes's theorem: counting techniques: Concept of random variable: Discrete and continuous variable: Variance: standard deviation and different types of distributions: Regression models and correlation coefficients: ANOVA: Estimation of statistical characteristics of data: Classical and Bayesian method of estimation: Estimation of Z-test: t-test and Goodness of fit test: Estimation theory and optimum estimators: Concept of uncorrelated: independent and orthogonal data.

Recommended Books

1. Introduction to Probability and Statistics, William Mendenhall, Robert J Beaver and Barbara M Beaver, Cengage Learning (Latest Edition)
2. Applied Statistics and Probability for Engineers, Douglas C Montgomery and George C Runger, John Wiley & Sons (Latest Edition)
3. Statistics: A Biomedical Introduction, Bryon W Brown and Myles Hollander, Wiley-Interscience (Latest Edition)
4. Schaum's Outline of Probability and Statistics, Murray Spiegel, John Schiller and R Srinivasan, McGraw Hill Education (Latest Edition)

Course Content
8.34 Clinical Laboratory Equipment

CODE & TITLE (BIT-322) Clinical Laboratory Equipment	CREDIT & CONTACT HOURS (2+1) 48 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Depth	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Discuss** the working principle, calibration, and maintenance of analytical equipment.	C-2	1
CLO-2	**Explain** the impact of chemical safety and biohazards on the environment and sustainable development.	C-2	7
CLO-3	**Observe** the working principle of laboratory instruments.	P-1	1
CLO-4	**Fix** and troubleshoot clinical laboratory equipment.	P-4	4

Course Outline for Theory

Understanding of clinical laboratory instrumentation principles: their specific applications and the process of instrument selection as well as their calibration and maintenance to produce quality analysis: particularly the following instruments: spectrophotometers: ion-selective electrodes: thermal equipment: centrifuges and balances: turbid meters. hematology analyzers: coagulation instruments: clinical chemistry analyzers: osmometers: electrochemistry: electrophoresis: chromatography: molecular techniques: automation and immunochemical methodologies.

Course Outline for Lab

1. Identify the types and uses of laboratory balances.
2. Explain the advantages of laboratory refrigerators.
3. Describe the importance of ovens, water baths and incubators.
4. State the use of photometers and desiccators.
5. Identify the types and uses of microscopes.
6. State the basic components centrifuge

Recommended Books

1. Locquin, M. Handbook of Microscopy. Butterworths. Boston (Latest Edition)
2. Raphael, S.S. Lynch's Medical Laboratory Technology. W.B. Saunders. Toronto (Latest Edition)

Course Content **8.35 Inter Disciplinary Technology Elective-I**		
CODE & TITLE (BII-321) **IDTE-I**	**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/DOMAIN** **IDTE**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of elective courses defined in this Curriculum. The HEI must ensure adequacy of academic and other resources for the course.		
Course Content **8.36 Inter Disciplinary Technology Elective-II**		
CODE & TITLE (BII-322) **IDTE-II**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 16 Lab**	**KNOWLEDGE AREA/DOMAIN** **IDTE**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of elective courses defined in this Curriculum. The HEI must ensure adequacy of academic and other resources for the course.		

Course Content **8.37 Project-II**			
CODE & TITLE (BIT-323) **Project-II**	**CREDIT & CONTACT HOURS** (0+3) **0 Theory + 144 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Project**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Apply** fundamental knowledge of engineering technology for implementation of proposed project idea along with comparison with previous related research.	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 its efficacy for sustainable development.	C-5	7
CLO-4	**Develop** a wide range of technical skills by delivering a working prototype using latest design tools that have passed through the design, implementation, testing and evaluation stages.	C-6	3
CLO-5	**Integrate** the solution of complex engineering technology problems for improvement of society or environment.	A-4	6
CLO-6	**Practice** and adopt ethical values in various methods.	A-5	8
CLO-7	**Demonstrate** effectiveness as an individual as well as a team member.	A-4	9
CLO-8	**Display** communication skills through presentations, technical reports, and posters .	A-5	10
CLO-9	**Display** the results of hardware components testing.	P-5	5

Course Content **8.38 Management Sciences Elective-III**		
CODE & TITLE (BIH-411) (BIM-411) **Management Science Elective-III**	**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/DOMAIN** **Management Science**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of elective courses defined in this Curriculum. The HEI must ensure adequacy of academic and other resources for the course.		
Course Content **8.39 Depth Elective-I**		
CODE & TITLE (BIT-412) **Depth Elective-I**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/DOMAIN** **Depth Elective**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of elective courses defined in this Curriculum. The HEI must ensure adequacy of academic and other resources for the course.		
Course Content **8.40 Depth Elective-II**		
CODE & TITLE (BIT-413) **Depth Elective-II**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/DOMAIN** **Depth Elective**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of elective courses defined in this Curriculum. The HEI must ensure adequacy of academic and other resources for the course.		
Course Content **8.41 Depth Elective-III**		
CODE & TITLE (BIT-414) **Depth Elective -III**	**CREDIT & CONTACT HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/DOMAIN** **Depth Elective**
The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of elective courses defined in this Curriculum. The HEI must ensure adequacy of academic and other resources for the course.		

Course Content
8.42 Troubleshooting of Medical Devices

CODE & TITLE (BIT-411) **Troubleshooting of Medical Devices**	**CREDIT & CONTACT HOURS** (0+1) **0 Theory + 48 Lab**	**KNOWLEDGE AREA/DOMAIN** **Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Identify** the protocols required for troubleshooting of medical devices.	P-1	1
CLO-2	**Demonstrate** skills required to effectively calibrate and maintain medical devices.	P-2	5
CLO-3	**Fix** medical equipment using troubleshooting skills at component, board, and system levels.	P-4	4

Course Outline for Lab

Troubleshooting of electronic circuit: Testing of Medical Devices: Safety guidelines for troubleshooting and testing: High voltages and high currents safety guidelines: Magnetic circuit/equipment safety guidelines: Fault finding techniques in medical devices: What are the basic troubleshooting techniques: What are the basic testing techniques: What are the tools used in troubleshooting and testing of medical devices: Introduction to protocols for troubleshooting of devices: Acceptance testing of medical device procedure and protocols: Calibration of medical devices: Corrective maintenance of medical devices: Troubleshooting software and laptop computers to connect to computer-based laboratory or imaging equipment: Component Level Troubleshooting: Board Level Troubleshooting: System level Troubleshooting

Recommended Books

1. Repair and Maintenance of Medical Devices: Basic Clinical Equipment, Shashi Sinha (Latest Edition)
2. Medical Equipment Management, Kieth Wilson (Latest Edition)
3. Frank D. Petruzella, "Electrician's Troubleshooting and Testing Pocket Guide," McGraw-Hill (Latest Edition)

Course Content
8.43 Depth Elective-IV

CODE & TITLE (BIT-4135) **Depth Elective -IV**	**CREDIT & CONTACT HOURS** (3+0) **48 Theory + 0 Lab**	**KNOWLEDGE AREA/DOMAIN** **Depth Elective**

The course (with outline, CLO's etc.) to be offered by HEI from amongst the list of elective courses defined in this Curriculum. The HEI must ensure adequacy of academic and other resources for the course.

Course Content
8.44 Biomedical Signal Processing

COURSE TITLE (BIT-414) Biomedical Signal Processing	CREDIT HOURS (2+1) 32 Theory + 48 Lab	KNOWLEDGE AREA/ DOMAIN Elective Depth	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the Nyquist criterion for sampling of continuous time signals, sampling rate conversion, and discrete time implementation of continuous time systems.	C-2	1
CLO-2	**Apply** a signal processing system using flow graph representation and fast Fourier transform.	C-3	1
CLO-3	**Solve** problems related to design of filters such as FIR filters, IIR filters.	C-3	3
CLO-4	**Reproduce** the experiments related to the design and implementation of digital filters.	P-2	5

Course Outline for Theory

Review of signals and systems and their properties: Modeling of Dynamic Systems: Linear Constant Coefficients Differential Equation (LCCDE) and Difference Equation: Review of Laplace transform: Transfer Function: Poles and Zeros: Sampling and Reconstruction: up-sampling and down sampling: Z-transform and its application in the analysis of Discrete LTI system: computation of frequency response from Pole: Zero plot: Review of the Frequency domain analysis of Continuous time systems: CTFS: CTFT: DTFT: DFT (DTFS): FFT: Design and implementation of analog and digital finite impulse response (FIR) and infinite impulse response (IIR) filters. A quick introduction to statistical signal processing: feature extraction and pattern recognition techniques: Case Studies of various Biomedical Signals: ECG: EEG

Course Outline for Lab

1. Introduction to MATLAB Signal Processing Toolbox
2. Signal generation, convolution, impulse response
3. Up- Down- Sampling
4. Spectral Leakage and Zero Padding
5. Introduction to Simulink
6. Sampling and Reconstruction through Simulink
7. Frequency Response of Discrete Time Systems
8. Implementation of FFT DIT algorithm in MATLAB
9. Design and Implementation of LP, HP filter
10. Design and Implementation of BP filters
11. Data classification
12. ECG acquisition and introduction MIT/BIH arrhythmia database
13. QRS Detection: Pan-Tompkins Algorithm Part I
14. QRS Detection: Pan-Tompkins Algorithm Part I
15. ECG Rhythm Analysis

Recommended Books
1. A. B. Carson, Signals and System, Wiley (Latest Edition) 2. John G. Proakis, Dimitris, Digital Signal Processing (Latest Edition) 3. Engene, N, Bruce, Biomedical Signal Processing and Signal Modeling , John Wiley & Sons (Latest Edition) 4. Arther, B. Ritter, Stanley Reisman&Bozena, B. Michniah, Biomedical Engineering Principles, CRC Taylor & Francis (Latest Edition) 5. John L. Semmlow, Biosignal and Biomedical Image Processing (Signal Processing) (Latest Edition) 6. Saeed V. Vaseghi, Communications, Advanced Digital Signal Processing and Noise Reduction (Latest Edition) 7. Charles C. Hsu (Editor), Charles Hsu, Advanced Signal Processing Technology (Latest Edition) 8. Allan V Oppenheim, Digital Signal Processing, Prentice Hall (Latest Edition)

Course Content
8.45 Biotelemetry System

COURSE TITLE (BIT-413) **Telemedicine Systems**	**CREDITS HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Elective Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Discuss** basics of Telemedicine Systems and applications.	C-2	1
CLO-2	**Interpret** the use of Mobile and Internet Technologies in Telemedicine.	C-2	7
CLO-3	**Use** the functions of DICOM, PACS for Telemedicine.	C-3	5
CLO-4	**Read** different types of images from DICOM.	P-2	5
CLO-5	**Organize** patient data into different classes based on their disease.	P-4	5

Course Outline for Theory

Introduction to Biotelemetry system: Basic Telemedicine Skills - demystifying the world of technology: using LAN and WAN technologies: Evolvement of Mobile and Internet Technologies in Telemedicine: Medical information storage and management for telemedicine: patient information: medical history: test reports: medical images: diagnosis and treatment: Security and Confidentially Functions of DICOM: PACS and HIS for Telemedicine

Course Outline for Lab

1. Identify the different kinds of access to Internet and email available locally: Discuss different communication options: Discuss the latest ICTs such as mobile phones: PDAs
2. Access the internet to: Do a literature search: download software: use an IP based educational software package
3. Setup a Contact list and Chat Group with access to a database
4. Generate images and save them in DICOM formats
5. Organize and group patient data into different groups based on their disease
6. Project and viva

Recommended Books

1. Telemedicine: A Guide to Assessing Telecommunications for Health Care (Latest Edition)
2. Telemedicine Technologies: Information Technologies in Medicine and Telehealth by A. C. M. Fong, Bernard Fong, and C. K. Li (Latest Edition)
3. Essentials of Telemedicine and Telecare by A. C. Norris (Latest Edition)
4. Introduction to Telemedicine, Richard Wootton, John Craig, Victor Patterson(Latest Edition)

Course Content
8.46 Medical Device Quality System and Standards

COURSE TITLE (BIT-415) **Medical Device Quality System and Standards**	**CREDITS HOURS** (1+0) **16 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Elective Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the quality management system for medical device manufacture.	C-2	1
CLO-2	**Compare** the approval process for new medical devices in different jurisdiction.	C-4	6

Course Outline for Theory

Quality Management System: Term and Definition: General Requirements: Quality Manual: Control of Documents: Controls of Records: Management Responsibility and Resource a. Management commitment Requirement: Planning: Responsibility: Authority: and Communication. Provision of Resources: Infrastructure and work environments: Product Realization: Planning of Product Realization: Customer Related Processes: Design and Development: Purchasing: Production and Service Provision: Validation of Processes of Production: Identification and Traceability: Control of Monitoring and Measuring: Regulation for Medical Devices by DRAP. Quality System Regulations (21CFR820).

Recommended Books

1. A Complete Guide to Quality Management in the Medical Device Industry, ItayAbuhav (Latest Edition)

Course Content
8.47 Medical Device Regulatory Affairs

COURSE TITLE (BIT-416) **Medical Device Regulatory Affairs**	**CREDITS HOURS** (1+0) **16 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Elective Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** major global reference regulations and harmonization efforts for medical devices, regulatory environment in key Asian markets for medical devices.	C-2	1
CLO-2	**Explain** general pre-market requirements, the legal logics behind the definition and regulation of advanced products.	C-2	1

Course Outline for Theory

Introduction to regulatory affairs
a: The role of RA b: Introduction to major global reference regulations and harmonization's c: Overview of regulatory environment in major Asian reference countries d: Future trends in regulatory development:
Pre-market requirements
a: Background b: Classifications c: GMP d: Conformity assessment
Advanced products
a: Combination products: Medical Device Errors a: Human Factors b: Electronic Health Records:
Investigational Device Exemptions
a: HDEs b: Medical Device 510(k) c: Pre-Market Approval (PMA) submissions d: de novo review and Product Development Protocol:
FDA Enforcement
a: FDA Post-market Transformation b: Medicare Reimbursement c: FDA and the Food and Drug laws:

Recommended Books

1. Medical Product Regulatory Affairs: Pharmaceuticals, Diagnostics, Medical Devices by John J. Tobin, Gary Walsh, ISBN: 978-3-527-31877-3 2 (Latest Edition)
2. Handbook of Medical Device Regulatory Affairs in Asia by Jack Wong, Raymond Tong Kaiyu (Latest Edition)

Course Content
8.48 Power Electronics

COURSE TITLE (BIT-417) **Power Electronics**	CREDITS HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Elective Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the modern semiconductor devices, their switching and protection methods and the operation of different power converter applications.	C-2	1
CLO-2	**Apply** the acquired knowledge to solve different power electronics circuits.	C-3	2
CLO-3	**Observe** knowledge of power electronics trainer board and thyristor-based power controller electronic circuits.	P-1	5
CLO-4	**Make** the setup for development of power electronic circuit such as controlled rectifier, inverter, dc chopper, cycloconverter and AC regulator and motor controlling using power electronic trainer board.	P-2	5

Course Outline for Theory

Introduction to power electronics a. History of power electronics b. Applications c. Power electronic devices d. Triggering devices e. Manufacturers datasheet f. Device protection, Diode circuits and rectifiers a. Diodes with RLC loads b. Freewheeling diodes c. Single phase rectifiers d. Poly phase rectifiers, Thyristor commutation a. Natural commutation b. Forced commutation c. Commutation circuit design, Controlled rectifiers a. Phase controlled converter operation b. Semi-converter c. Full converter d. Dual converter e. Series converters f. Power factor improvement g. Design converter circuits h. Effects of inductances, Static switches a. Single phase AC switches b. Polyphase AC switches c. DC switches d. Design of static switches, AC voltage controllers a. Single phase controllers b. Polyphase controllers c. Transformer tap changers d. Cycloconverters e. Design of AC voltage controller circuits f. Effects of inductances, DC choppers a. Introduction b. Step-down and step-up chopper operation c. Switching mode regulators d. Thyristor chopper circuits e. Chopper circuit design, Inverters a. Principles of operation b. Single phase inverters c. Polyphase inverters d. Voltage control of inverters e. Harmonic reductions , Cycloconverters a. Single phase cycloconverter circuits b. Three phase cycloconverter circuits, DC motor drive applications, Voltage source converters and control, Waveform analysis, harmonic minimization, PWM AC motor drives, Power electronic applications in power systems.

Course Outline for Lab

1. To become familiar with user interface of Pspice
2. To understand and design a circuit of 1-phase half and full wave uncontrolled rectifier.
3. To understand and design a circuit of 1-phase half wave-controlled rectifier (0 to 90 degree).
4. To understand and design a circuit of 1-phase half wave-controlled rectifier (0 to 180 degree).
5. To understand and design a circuit of 1-phase full wave-controlled rectifier.
6. To understand and design a circuit of 3-phase half wave uncontrolled rectifier.
7. To understand and design a circuit of 3-phase full wave uncontrolled rectifier.
8. To understand and design a circuit of 3-phase half wave-controlled rectifier.

9. To understand and design a circuit of 3-phase full wave-controlled rectifier.
10. To understand and design a circuit of a Buck converter.
11. To understand and design a circuit of a Boost converter.
12. To understand and design a circuit of a Buck- Boost converter.
13. To understand and design a circuit of Cuk Converter.
14. To understand and design a circuit of a Single-Phase Full Bridge Inverter.
15. Open ended lab.

Recommended Books

1. N. Mohan, T. M. Undeland, and W. P. Robbins, Power Electronics: Converters, Applications, and Design, Media Enhanced 3 rd Edition, John Wiley & Sons, Inc. (Latest Edition)
2. M. H. Rashid, Power Electronics: Circuits, Devices, and Applications, 4 th Edition, Prentice Hall (Latest Edition)
3. M. D. Singh and K.B. Khanchandani, 'Power Electronics', Tata McGraw-Hills Publishing Company Limited (Latest Edition)
4. Power Electronics--A First Course" Mohan, Wiley (Latest Edition)
5. Vedam Subramaniam, 'Power Electronics', New Age International (P) Ltd Publishers (Latest Edition)
6. Philip T. Krein, 'Elements of Power Electronics', Oxford University Press (Latest Edition)
7. V. R. Moorthi, 'Power Electronics-Devices, Circuits and Industrial Applications', Oxford University Press (Latest Edition)

Course Content
8.49 Medical Robotics

COURSE TITLE (BIT-418) **Medical Robotics**	CREDITS HOURS (2+1) **32 Theory + 48 Lab**	KNOWLEDGE AREA/ DOMAIN **Elective Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the fundamentals of robotics.	C-2	1
CLO-2	**Solve** the position and orientation of objects and the relationship between robot joint coordinates and tool position.	C-3	2
CLO-3	**Differentiate** between types and characteristics of actuators, control systems and operating interface of medical robots.	C-2	2
CLO-4	**Recognize** different movements of kinematics.	P-1	1
CLO-5	**Make** robotic arm with sensor actuation.	P-4	2

Course Outline for Theory

Fundamentals a. What is a Robot? b. Classification of Robots. c. What is Robotics? d. History of Robotics. e. Advantages and Disadvantages of Robots. f. Robot Components. g. Robot Degrees of Freedom. h. Robot Joints. i. Robot Coordinates. j. Robot Reference Frames. k. Programming Modes. l. Robot Characteristics. m. Robot Workspace. n. Robot Languages. o. Robot Applications. p. Other Robots and Applications. q. Social Issues.

Robot Kinematics a. Position Analysis. b. Robots as Mechanisms. c. Matrix Representation. d. Homogeneous Transformation Matrices. e. Representation of Transformations. f. Inverse of Transformation Matrices. g. Forward and Inverse Kinematics of Robots. h. Denavit-Hartenberg Representation of Forward Kinematic Equations of Robots. i. The Inverse Kinematic Solution of Robots. j. Inverse Kinematic Programming of Robots. k. Degeneracy and Dexterity. l. The Fundamental Problem with the Denavit-Hartenberg Representation. m. Differential Motions and Velocities.

Differential Relationships a. Jacobian. b. Differential Motions of a Frame. c. Interpretation of the Differential Change. 118 d. Differential Changes between Frames. e. Differential Motions of a Robot and Its Hand Frame. f. Calculation of the Jacobian. g. How to Relate the Jacobian and the Differential Operator. h. Inverse Jacobian. i. Design Project. j. Dynamic Analysis and Forces, Lagrangian Mechanics a. A Short Overview. b. Effective Moments of Inertia. c. Dynamic Equations for Multiple-Degree-of-Freedom Robots. d. Static Force Analysis of Robots. e. Transformation of Forces and Moments between Coordinate Frames. f. Design Project, Trajectory Planning a. Path vs. Trajectory b. Joint Space vs. Cartesian-Space. c. Basics of Trajectory Planning. d. Joint space trajectory planning, e. Cartesian space trajectories.

Application of Robotic in BME a. Introduction to medical robotics b. Mechanisms for medical robots c. Sensing for medical robots d. Actuators for medical robots e. Controls for medical robots f. Interfaces for medical robots

Course Outline for Lab

1. Introduction to the Rhino
2. The Tower of Hanoi
3. Forward Kinematics
4. Inverse Kinematics
5. Image Processing

6. Camera Calibration
7. Object Centroids
8. Camera Calibration
9. Pick and Place
10. Grading
11. Tactile and force sensing
12. Proximity sensing
13. Medical robotics
14. Open ended lab 1
15. Open ended lab 2
16. Open ended lab 3

Recommended Books

1. Robotics: Everything You Need to Know About Robotics from Beginner to Expert, Peter Mckinnon (Latest Edition)
2. Robotics, Vision and Control: Fundamental Algorithms in MATLAB (Latest Edition)
3. Springer Handbook of Robotics, Siciliano, Bruno, Khatib, Oussama (Latest Edition)
4. Robotics Modelling, Planning and Control, Siciliano, B.,Sciavicco, L., Villani, L., Oriolo (Latest Edition)
5. Medical Robotics: Minimally Invasive Surgery, Paula Gomes, ISBN:9780857097392, (Latest Edition)
6. Medical Robotics, Schweikard, Achim, Ernst, Floris (Latest Edition)

Course Content
8.50 Rehabilitation Techniques

COURSE TITLE	CREDITS HOURS	KNOWLEDGE AREA/ DOMAIN	
(BIT-419) **Rehabilitation Engineering Technology**	(2+1) **32 Theory + 48 Lab**	**Elective Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the domains of rehabilitation engineering technology.	C-2	1
CLO-2	**Explain** working principles of prosthetic, orthotic, and devices for visually as well as hearing impairment.	C-3	1
CLO-3	**Measure** physiological parameters during electrical stimulation.	P-4	5
CLO-4	**Operate** assistive devices for hearing and visually impaired.	P-3	5

Course Outline for Theory

Introduction a. Introduction to rehabilitation engineering and assistive technology (AT) b. Domains of rehabilitation techniques, Limb Prosthetic Devices a. Classification of amputation b. Prosthetic prescription and fabrication c. Components of upper limb prosthesis d. Components of lower limb prosthesis, Orthotic Devices a. Introduction b. Biomechanical principles of orthoses c. Design consideration d. Spinal orthoses e. Limb orthoses, Devices for Visually Impaired a. Dimensions of visual impairment and their impact on task performance b. General purpose assistive technology solutions c. Task-specific assistive technologies d. Technology for reading e. Writing and graphic access, Devices for Hearing Impairment a. Types of hearing impairment b. Historical overview of HAT (Hearing assistance technology) c. Medical and surgical approaches to restoring hearing function d. Assistive listening devices solutions e. Environmental adaptations and universal designs, Wheelchairs a. Manual wheelchairs and electrical power wheelchairs with brief history b. User profiles c. Basic structural components d. Power and drive systems e. Control system f. Power assisted wheelchairs g. Multifunctional wheelchairs h. Wheelchair standards, Neurorehabilitation a. Functional Electrical Stimulation b. Transcutaneous Electrical Stimulation c. Brain Computer Interface d. Assessment methods for neurorehabilitation.

Course Outline for Lab

1. Angle measurements using electronic goniometer in rest and walking state
2. Foot pressure measurement using force sensitive resistors (FSR)
3. Modeling and simulation of biomechanics arm using Autocad
4. Gait parameter analysis 5. EMG measurement during Functional electrical stimulation (FES)
5. Assessment of EMG before and after TENS
6. Design of brain computer interface using neurosky EEG device to detect subject's response
7. Control of peripheral devices such as using neurosky EEG device to switch ON/OFF home appliances
8. Demonstration of electrical power wheelchair
9. Demonstration of hearing aid.
10. Demonstration of visually impaired devices.
11. Open ended Lab 1
12. Open ended Lab 2
13. Open ended Lab 3

14. Open ended Lab 4
15. Open ended Lab 5

Recommended Books

1. Rory A Cooper and HisaichiOhnabe, An Introduction to Rehabilitation Engineering, ISBN: 9780849372223 (Latest Edition)
2. Pedro Encarnação and Albert Cook, Robotic Assistive Technologies: Principles and Practice, ISBN: 9781498745727 (Latest Edition)
3. Marko B. Popović, Biomechanics and Robotics, ISBN: 9789814411370 (Latest Edition)
4. Albert M. Cook and Janice Miller Polgar, Assistive Technologies: Principles and Practice, 4th Edition, ISBN: 9780323096317 (Latest Edition)
5. Kevin Russell Henderson, Wheelchairs: Perceptions, Technology Advances and Barriers, ISBN: 9781536103908 (Latest Edition)
6. Michelle M. Lusardi, Orthotics and Prosthetics in Rehabilitation, ISBN: 9781437719369 (Latest Edition)

Course Content
8.51 Tissue Engineering Technology

COURSE TITLE (BIT-4110) **Tissue Engineering**	**CREDITS HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Elective Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the field of tissue engineering.	C-1	1
CLO-2	**Discuss** the cell culture technique, Bioreactor, cell proliferation, extracellular matrix, and growth factors.	C-2	5
CLO-3	**Apply** tissue engineering technology principles to design a specific biological tissue.	C-3	3

Course Outline for Theory

Introduction to Tissue Technology a. Fundamentals of Stem Cell Tissue b. Extracellular Matrix: Structure, Function, and Applications to Tissue Technology c. Polymeric Scaffolds for Tissue Applications d. Nanocomposite Scaffolds for Tissue Technology , Tissue-Biomaterial interaction and response a. Cell Adhesion b. Cell Migration c. Inflammatory and Immune Responses to Tissue Devices, Tissue Technology Applications a. Bioengineering of Human Skin Substitutes b. Bone Tissue Technology, c. Cartilage Tissue Technology d. Cardiac Tissue Technology e. Muscle Tissue Technology, Growth Factors a. Growth Factors and Morphogens: Signals for Tissue Technology, Ethical and regulatory issues in tissue engineering

Recommended Books

1. Buddy D. Ratner, et. al, Biomaterials Science, Second Edition: An Introduction to Materials in Medicine (Latest Edition)
2. Handbook of Biomaterial Properties, William Murphy, Jonathan Black, Garth Hastings (Latest Edition)
3. David Hill, Design Engineering of Biomaterials for Medical Devices (Latest Edition)
4. Jos Vander Sloten, Computer Technology in Biomaterials Science and Engineering (Biomaterials Science & Engineering) (Latest Edition)
5. Kay C. Dee, et al, An Introduction to Tissue-Biomaterial Interactions (Latest Edition)
6. Temenoff, J. S, Biomaterials: The intersection of biology & materials science, (Latest Edition)
7. Tissue Regeneration - From Basic Biology to Clinical Application, Edited by Jamie Davies, ISBN 978-953-51-0387-5 (Latest Edition)

Course Content
8.52 Drug Delivery Systems

COURSE TITLE (BIT-4111) **Drug Delivery Systems**	**CREDITS HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Elective Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** novel drug delivery systems.	C-2	1
CLO-2	**Investigate** different approaches used for controlled drug delivery systems .	C-4	4
CLO-3	**Apply** ethical obligations in controlled drug delivery systems.	C-3	8

Course Outline for Theory

Diffusion and Drug Dispersion a. Equations for the diffusive flux (Fick's law) b. Equations of mass conservation (Fick's second law) c. Solutions to the diffusion equation with no solute elimination or generation d. Solutions to the diffusion equation with solute binding and elimination e. Applications, Diffusion in Biological Systems a. Measurement of diffusion coefficients b. Diffusion in water c. Diffusion in polymer solutions and gels d. Diffusion in the extracellular space e. Diffusion with binding in tissues f. Diffusion within cells g. Diffusion and reaction, Drug Permeation through Biological Barriers a. Mobility of lipids and proteins in the membrane b. Permeation through lipid membranes c. Permeation through porous membranes d. Permeation is enhanced by membrane proteins e. Permeation through cell layers, Drug Transport by Fluid Motion a. Blood movement in the circulatory system b. Interstitial fluid movement c. Fluid movement in the lymphatic circulation d. Fluid movement in the brain, Drug Delivery Systems a. Reservoir and transdermal delivery systems b. Matrix delivery systems c. Hydrogel delivery systems d. Degradable delivery systems e. Particulate delivery systems f. Responsive delivery system, Case Studies in Drug Delivery a. Controlled delivery of systemic therapy b. Implants for local drug delivery c. Topically applied devices for controlled release d. Ethical issues in Drug Delivery Systems

Recommended Books

1. Drug Delivery: Engineering Principles for Drug Therapy by Saltzman; Oxford University Press (Latest Edition)

Course Content
8.53 Artificial Intelligence

COURSE TITLE (BIT-4112) **Artificial Intelligence**	**CREDITS HOURS** (2+1) **32 Theory + 48 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Elective/Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Comprehend** the basics of artificial intelligence with emphasize on search algorithms and the concept of AI agents.	C-2	1
CLO-2	**Apply** various search algorithms such as uninformed, informed and heuristic.	C-3	2
CLO-3	**Describe** fundamentals of knowledge representation, inference and theorem proving.	C-2	1
CLO-4	**Demonstrate** simple knowledge-based systems.	P-3	3

Course Outline for Theory

Introduction to Artificial Intelligence:
a. Foundations of AI b. Agents and Environments. c. Structure of Agents. d. Problem Solving Agents
Problem Solving by Searching:
a. Searching for Solutions. b. Uninformed Search Strategies c. Informed Search Strategies
Informed (Heuristic) Search Strategies: a. Greedy Best-first Search. b. A* Search. c. Heuristic Functions, Reasoning and Knowledge Representation
Introduction to Reasoning and Knowledge Representation:
a. Propositional Logic. b. First order Logic. c. Reasoning with Uncertainty & Probabilistic Reasoning d. Acting Under Uncertainty. e. Bayes' Rule,
Learning Decision Trees:
a. ID3 Algorithm b. Statistical Learning.

Course Outline for Lab

1. Introduction to AI related programming languages.
2. Generating and Processing Undirected and Directed Graphs.
3. Developing AI agents.
4. Develop small Agent networks.
5. Breadth First Graph Search Algorithm.
6. Depth First Graph Search Algorithm.
7. A* Heuristic Search Algorithm,
8. Greedy First Heuristic Search Algorithm.
9. Min Max Constraint Satisfaction Problem.
10. Implement of Propositional Logic.
11. Implementation of First order logic.
12. Reasoning with Uncertainty.
13. Implementation of Probabilistic Reasoning.
14. Implementation of Bayes' Rule.

15. Decision Tree Algorithm.
16. Implementing ID3 Algorithm.

Recommended Books

1. Russell S.; Norvig P.; "Artificial intelligence – A Modern Approach", Prentice Hall (Latest Edition)
2. Luger G.F.; Artificial Intelligence – Structures and Strategies for Complex Problem Solving", Pearson Higher Education (Latest)

Course Content
8.54 Bioinformatics

COURSE TITLE (BIT-4113) **Bioinformatics**	**CREDITS HOURS** (2+0) **32 Theory + 0 Lab**	**KNOWLEDGE AREA/ DOMAIN** **Elective Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Discuss** fundamentals of Genomics and Transcriptomics with respect to bioinformatics.	C-1	1
CLO-2	**Describe** the structure, classification, and functions of proteins and DNA.	C-2	2
CLO-3	**Compare** protein sequences.	C-4	1
CLO-4	**Carryout** research to retrieve DNA and protein sequences.	C-3	4

Course Outline for Theory

History and evolution of bioinformatics:

a. Introduction to databases (Database types, Database formats, DNA databases, European Molecular Biology Laboratory (EMBL) b. Genomics c. Transcriptomics d. Computational proteomics

Pairwise Sequence Alignment:

a. Evolutionary Basis b. Sequence Homology versus Sequence Similarity c. Sequence Similarity versus Sequence Identity

Database Similarity Searching:

a. Unique Requirements of Database Searching b. Heuristic Database Searching c. Basic Local Alignment Search Tool (BLAST) d. FASTA e. Comparison of FASTA and BLAST

GenBank and DNA Data base of Japan (DDBJ):

a. Protein information Resource (PIR) formats b. Protein Sequence (databases, SwissProt, UniProt, UniProtKB/TrEMBL) c. Structural databases (Protein Databank (PDB), Structural Classification of Proteins (SCOP) database: Class: Architecture: Topology: Homology (CATH) database).

Recommended Books

1. Introduction to Bioinformatics, Arthur M. Lesk, 4th Edition, Oxford University Press, ISBN 0198724675, 9780198724674 (Latest Edition)
2. Bioinformatics and Functional Genomics, Jonathan Pevsner, Wiley, ISBN 0470085851, 9780470085851 (Latest Edition)

Course Content
8.55 Medical Image Processing

COURSE TITLE	CREDITS HOURS	KNOWLEDGE AREA/ DOMAIN	
(BIT-412) **Medical Image Processing**	(2+1) **32 Theory + 48 Lab**	**Elective Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Explain** the fundamentals of Medical Image Processing techniques (spatial domain, frequency domain, noise removal, image reconstruction and image segmentation).	C-2	1
CLO-2	**Analyze** the medical image to remove noise.	C-4	2
CLO-3	**Practice** various filtration techniques on medical images using software tools.	P-3	5
CLO-4	**Perform** the segmentation and classification on different medical images using software tools.	P-5	5

Course Outline for Theory

Digital Image Fundamental:
a. Image file formats b. Elements of Visual Perception c. Image Sampling and Quantization d.
An Introduction to the Mathematical Tools Used in Digital Image Processing, Intensity Transformations and Spatial Filtering:
a. Basic Intensity Transformation Functions b. Histogram Processing c. Fundamentals of Spatial Filtering d. Smoothing Spatial Filters e. Sharpening Spatial Filters, Filtering in the Frequency Domain:
a. Review of Concept about Fourier in 1D b. Fourier Functions of Two Variable c. The Basics of Filtering in the Frequency Domain d. Image Smoothing Using Frequency Domain Filters e. Image Sharpening Using Frequency Domain Filters,
Image Restoration and Reconstruction:
a. Noise Models b. Restoration in the Presence of Noise Only-Spatial Filtering c. Periodic Noise Reduction by Frequency Domain Filtering d. Inverse Filtering, Least Squares Filtering, GM filtering e. Image
Reconstruction from Projections, Image Segmentation:
a. Point, Line, and Edge Detection b. Thresholding c. Region-Based Segmentation d. Segmentation Using Morphological Watersheds e. The Use of Motion in Segmentation, Image Compression:
a. Compression Standards b. Some Basic Compression Methods (Huffman Coding, Golomb Coding)

Course Outline for Lab

1. MATLAB: Introduction to MATLAB and image processing toolbox
2. Digital Image Fundamentals: Sampling and quantization, bits per pixel & shades, spatial resolution & image size, Zooming & shrinking images
3. Basic Gray Level transformations: Image Negative, Log transform.
4. Application Of Gamma Correction to enhance image
5. Contrast stretching and thresholding
6. Introduction to image Histogram , Histogram sliding
7. Histogram equalization

8. Enhancement using arithmetic/logic operations
9. Smoothing spatial filters (Mean and Median filters)
10. Sharpening spatial filters (Laplace and Sobel)
11. Un-sharp masking and high-boost filtering Combining Spatial Enhancement methods
12. Review of Fourier transform and convolution theorem, 2D-FT, FT and frequency components of an image
13. Lowpass and Highpass Filters: Ideal filters, Butterworth filters, Gaussian filters. Filters comparison, Unsharp Masking
14. Dilation and erosion
15. Detection of discontinuities, Edge linking and boundary detection, Segmentation by thresholding
16. Object recognition, classification and image compression

Recommended Books

1. Digital Image Processing for Medical Applications by Geoff Dougherty, Cambridge University Press (Latest Edition)
2. Digital Image Processing by Gonzales, R. C., Prentice Hall, New Jersey (Latest Edition)

Course Content
8.56 Hospital Information System

COURSE TITLE (BIT-4114) **Hospital Information System**	CREDITS HOURS (2+0) **32 Theory + 0 Lab**	KNOWLEDGE AREA/ DOMAIN **Elective Depth**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** concepts, components, and applications of Hospital Information System (HIS).	C-1	1
CLO-2	**Explain** latest developments in Hospital Management and Information Systems.	C-2	1
CLO-3	**Demonstrate** benefits of Electronic Health Records (EHRs) and use of Decision Support Systems (DSS) in HIS.	C-3	3
CLO-4	**Investigate** action plan to transform traditional hospital information systems to modern HIS with EHRs and DSS for improved efficiency.	C-4	6

Course Outline for Theory

Introduction:
a. Basics of Information Systems b. Rudiments of Healthcare Information Management System c. HIS, Now and future, Data standards, Handling and Processing:
a. Data representation b. Storage Tiers c. Data Structure d. Flow Charts and Work Process Flow Diagrams e. Electronic Health Records (HERs) f. Pros & Cons of Paper medical records g. Functions and Benefits of EHRs,
Subsystems of HIS:
a. Health Information Systems in Clinical Settings b. Laboratory Information Systems c. Radiology Information Systems d. Clinical Decision Support Systems (CDSS) e. Healthcare Financial Management, Network and Communication
a. Medical device networking b. DICOM c. HL7 standards.

Recommended Books

1. Strategic Information Management in Hospitals: An Introduction to Hospital by Reinhold Haux ISBN:0-378-40356-6 (Latest Edition)
2. Medical Data Management: A Practical Guide ISBN 978-0-387-21773-4 (Latest Edition)

Course Content
8.57 Professional Ethics

COURSE TITLE (BIS-121) **Professional Ethics**	CREDITS HOURS (3+0) **48 Theory + 0 Lab**	KNOWLEDGE AREA/ DOMAIN **Social Science Elective**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Comprehend** the basis 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	7
CLO-2	**Acquire** knowledge of various roles of engineering technologist in applying ethical principles at various professional levels.	A-3	6
CLO-3	**Resolve** the ethical dilemmas using common ethical values and identify possible actions to be taken in response.	A-5	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, (Latest Edition)
2. Kenneth Blanchard, Professional Ethics, (Latest Edition)
3. Ethics in Engineering, by Mike W. Martin, Roland Schinzinger, McGraw-Hill, (Latest Edition)
4. The Seven Habits of Highly effective people by Stephan r. Covey (Latest Edition)
5. Engineering Ethics: Concepts and Cases, by Charles E. Harris, Michael S. Pritchard, Michael J. Rabins, Wadsworth, (Latest Edition)
6. Professional Ethics: R. Subramanian, Oxford University Press, (Latest Edition)
7. Ethics in Engineering Practice & Research, Caroline Whitbeck, 2e, Cambridge University Press (Latest Edition)

Course Content
8.58 Organizational Behavior

COURSE TITLE (BIS-122) **Organizational Behavior**	CREDITS HOURS (3+0) **48 Theory + 0 Lab**	KNOWLEDGE AREA/ DOMAIN **Social Science Elective**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Describe** the field of organizational behaviour and the impact of organizational culture on individuals and the workplace.	A-1	9
CLO-2	**Explain** group dynamics within organizations, impact of diversity on the workplace, and strategies to manage groups and teams.	A-3	9
CLO-3	**Discuss** theories of motivations, importance of managing stress and emotions, and strategies to manage change and improve motivation in the workplace.	A-2	9

Course Outline for Theory

Overview; Introduction to the field of organizational behaviour; motivation; Individual and group behaviour; Personality and values; Perceiving ourselves and others in organizations; Workplace emotions; Attitudes; and stress foundations of employee motivation; Applied performance practices; Decision making and creativity; Team dynamics; Communicating in organizations; Power and politics in the workplace; Conflict and negotiation in the workplace; Leadership in organizational settings; Designing organizational structure; Organizational culture; Organizational change and development.

Recommended Books

1. Canadian Organizational Behavior McShane, Steven L. & Sheen, Sandra L. McGraw Hill Ryerson, (Latest Edition)
2. Organizational Behavior, by Robbins & Judge, Prentice-Hall Publishing, (Latest Edition)
3. Luthan Fred, Organizational Behaviour, McGraw Hill Inc, (Latest Edition)
4. Robins, Stephen, Organizational Behaviour, McGraw Hill Inc. (Latest Edition)
5. Finchan, R., & Rhodes, P. Principles of Organizational Behaviour, Oxford Press (Latest Edition)

Course Content
8.59 Critical Thinking

COURSE TITLE (BIS-211) **Critical Thinking**	CREDIT HOURS (3+0) **48 Theory + 0 Lab**	KNOWLEDGE AREA/ DOMAIN **Social Sciences**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Use** critical thinking skills when making business decisions and react with curiosity instead of emotion.	C-1	12
CLO-2	**Choose** the right techniques to recognize assumptions and draw conclusions.	C-3	12
CLO-3	**Translate** an abstract idea into something tangible.	P-4	12

Course Outline for Theory

Understanding Critical Thinking: What is Critical Thinking; Characteristics of a Critical Thinker; Common Critical Thinking Styles Making Connections; Left- and Right-Brain Thinking; and Whole-Brain Thinking; The Critical Thinking Process: The Critical Thinking Model; the Standards of Critical Thinking; Identifying the Issues; Identifying the Arguments; Clarifying the Issues and Arguments; Establishing Context; Checking Credibility and Consistency; Evaluating Arguments; Case Study; Developing Critical Thinking Skills: Asking Questions; Probing Techniques; Pushing My Buttons; Critical Thinking Questions; Active Listening Skills; challenging assumptions; Creating Explanations: Defining Explanations; Steps to Building an Explanation; Making Connections; Creative Thinking Techniques: Brainstorming; imagining the opposite; Mind mapping; DeBono's thinking Hats; Techniques for Thinking Creatively; Creative Thinking Exercise; Presenting and communicating your ideas to others.

Recommended Books

1. Diestler, Sherry. Becoming a Critical Thinker. New Jersey: Prentice Hall, (Latest Edition)
2. Browne, M. Neil, and Stuart M. Keeley. Asking The Right Questions. New Jersey: Prentice Hall, (Latest Edition)

Course Content
8.60 Professional Psychology and Human Behavior

COURSE TITLE	CREDIT HOURS	KNOWLEDGE AREA/DOMAIN	
(BIS-212) **Professional Psychology & Human Behaviour**	(3+0) **48 Theory + 0 Lab**	**Social Sciences**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** the complexity of human behaviour and relationships.	C-2	1
CLO-2	**Comprehend** psychology as science and empirical methods used for understanding different aspects of human behaviour.	C-2	4
CLO-3	**Apply** the skills in research and evaluation within a scientific framework to interact with different professionals and do an effective communicate information in both verbal and non-verbal way.	C-3	10

Course Outline for Theory

Understanding Psychology: Scientific perspective of Psychology; Historical perspective; Schools of psychology; Methods of psychology; Ethical issues; Fields of psychology and their application; Biological Basis of Behaviour: Neuron and its function; Central nervous system; Peripheral nervous system; Endocrine system; Sensation and Perception: Senses: Vision; audition; smell; taste and kinesthetics; introduction to perception; Kinds of Perception; Gestalt principles; Binocular and monocular cues; Illusions and extra sensory perception; Learning: Definition of learning; Types of learning: Classical and operant conditioning; Punishment and its effects; Latent and observational learning; Memory: Definition and types of memory; Processes and techniques of improving memory; forgetting: Nature and causes; Cognition and Language: Concept of cognition; Problem solving; Judgment and decision making; Language development; Language and cognition; Language and culture; Intelligence and Creativity: Concept of intelligence; Theories of intelligence; Assessment of intelligence Mental retardation; Concept of creativity and its stages; Motivation and Emotion: Introduction to motivation; Factors affecting motivation; Introduction to emotions; Types of emotions; Physiological changes during Emotions (Neural; Cardiac; Visceral; Glandular); Theories of emotion; Social Thinking and Social Influence: Definition and nature of thinking; Tools of thinking; kinds of thinking; Social facilitation; Attribution theory; Crowd behaviour; Conformity; Obedience; Helping behaviour

Recommended Books

1. Atkinson R. C., & Smith E. E. Introduction to psychology(13thed.). Harcourt Brace College Publishers, (Latest Edition)
2. Fernald,L.D.,& Fernald,P.S. Introduction to psychology. USA: WMC Brown Publishers, (Latest Edition)
3. Glassman, W. E. Approaches to psychology. Open University Press (Latest Edition)
4. Hayes, N. Foundation of psychology Thomson Learning. Lahey, B. B. Psychology: An introduction McGraw-Hill Companies, Inc. (Latest Edition)
5. Coon, D., &Mutterer, J. Introduction to psychology: Gateways to mind and behavior Wadsworth Cengage Learning (Latest Edition)
6. Fredrickson, B., Nolen-Hoeksema, S.,Loftus, G., &Wagenaar, W. Atkinson & Hilgard's introduction to psychology USA:

Wadsworth (Latest Edition)
7. Kalat, J. W. Introduction to psychology. USA: Cengage Learning, Inc. (Latest Edition)
8. Lahey, B. B. Psychology: An introduction UK: McGraw-Hill Companies, Inc. (Latest Edition)
9. Leahey, T. H. A history of psychology: Main currents in psychological thought. New Jersey: Prentice-Hall International, Inc, (Latest Edition)

Course Content
8.61 Fundamentals of Economics

COURSE TITLE	CREDITS HOURS	KNOWLEDGE AREA/ DOMAIN	
(BIM-121) **Fundamentals of Economics**	(3+0) **48 Theory + 0 Lab**	**Management Science Elective**	
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	2
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	11
CLO-3	**Analyze** the appropriate engineering technology economics analysis method(s) for problem solving i.e., present worth, annual cost, rate of return, payback, break-even and benefit-cost ratios.	C-4	2

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 Donal G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, 12th edition, Oxford University Press, (or Latest Edition)

Course Content
8.62 Entrepreneurship

COURSE TITLE	CREDIT HOURS	KNOWLEDGE AREA/ DOMAIN	
(BIM-221) **Entrepreneurship**	(3+0) **48 Theory + 0 Lab**	**Management Science Elective**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** entrepreneurship concept as a whole and the role of entrepreneurship in economic development.	A-3	7
CLO-2	**Compare** the role and importance of the small and medium sized enterprises in the economy.	A-4	6
CLO-3	**Find** an attractive market and apply the understanding of business planning concept for new business creation and growth.	A-3	12

Course Outline for Theory

The concept of entrepreneurship; the economist view of entrepreneurship; the sociologist view; Behavioral approach; Entrepreneurship and Management. The process of entrepreneurship; Entrepreneurial Management; The entrepreneurial business; Entrepreneurship in service institutions; the new venture. 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 (Latest Edition)
2. Paul Burns and Jim Dew Hurst: "Small Business and Entrepreneurship", Palgrave Macmillan Publishing Company, Second Edition (Latest Edition)
3. Peter F. Drucker: "Innovation and Entrepreneurship", Harper Business, Reprint Edition (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, (Latest Edition)
5. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses by Eric Ries, Penguin Books (Latest Edition)
6. John B. Miner, "Entrepreneurial Success", Berrett-Koehler Publishers, (Latest Edition)

Course Content
8.63 Project Management

COURSE TITLE	CREDIT HOURS	KNOWLEDGE AREA/DOMAIN	
(BIM-411) **Project Management**	(3+0) **48 Theory + 0 Lab**	**Management Science Elective**	
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 for Theory

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 tool: Introduction and use of project management tools like MS project and primavera.

Recommended Books

1. A Guide to the Project Management Body of Knowledge (PMBOK Guide), Project Management Institute (Latest Edition)
2. Project Management: A Systems Approach – A Book Review, Harold Kerzner, ISBN-10: 1118022270; ISBN-13: 978-1118022276 (Latest Edition)

Course Content
8.64 Principles of Marketing

COURSE TITLE (BIM-412) **Principles of Marketing**	CREDIT HOURS (3+0) **48 Theory + 0 Lab**	KNOWLEDGE AREA/DOMAIN **Management Science Elective**	
After completion of this course, students will be able to:		**Bloom's Taxonomy Level**	**PLO**
CLO-1	**Understand** marketing philosophies and marketing environment.	C-2	1
CLO-2	**Apply** marketing mix techniques to manage business efficiently and effectively.	C-3	12

Course Outline for Theory

Introduction to Marketing: What is Marketing, understanding marketplace and customer needs, Customer driven marketing strategy, preparing marketing plan and capturing customer value, changing landscape of marketing. Marketing Mix and managing marketing effort.

Understanding Market and Customer: Microenvironment, Macro environment, developing marketing information, marketing research, analysing and using market information, Models of Consumer Behaviour, Factors Influencing Consumer, Types of Buying Decision, Consumer Buying Process

Making Product the Brand- creating value: What is product, Service and Experience, Product line and Product mix, product classification and Branding Strategy, product life cycle and new product development process?

Pricing – understanding and capturing value: What is price, pricing strategies, new product pricing strategy, product mix pricing strategy and price adjustment strategy?

Marketing Channel – delivering customer value: Supply chain and value delivery network, Types of channels, Decision of channel, retailing and whole selling.

Promotion – Communicating customer value: The promotion mix, integrated marketing communication, effective marketing communication, socially responsible communication, advertising and public relations, personal selling and personal selling process and sales promotion.

Creating Competitive Advantage: Competitor analysis whom to attack and avoid and competitive strategies

Recommended Books

1. Principles of Marketing, Philip Kotler, Gary Armstrong, John Saunders and Veronica, (Latest Edition)
2. Marketing: Principles and Strategies Hardcover by Charles D. Schewe, (Latest Edition)

9. Supervised Industrial Training

9.1 Background

Supervised Industrial Training (SIT) refers to students supervised hands-on experience in an environment where engineering technology is practiced, familiarizing them with professional engineering 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 developing professional skills required for an Engineering Technologist, it also offers an opportunity to the prospective employers to assess potential skills of a future employee.

9.2 Objectives:

Through the SIT, students will:

a. Learn to apply engineering technology knowledge learned in classroom environment 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.

9.3 Responsibility of HEI: Placement in SIT Program

During 7th (Optional) and 8th semester, Bachelor of Biomedical 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.

9.4 Responsibilities of Students:

a. Bachelor of Biomedical 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 Training period of 16 (or 32) for genuine reasons. The leave shall only be availed to cater for emergency/s, 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 leaves should not be counted as working hours.

9.5 Training Progress Assessment and Review by HEI

Every HEI should appoint a focal person as SIT Administrator/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.

9.6 Changing Student Placement During SIT

a. Students are discouraged to change placement during the training period from one organization to another.

b. However, written permission may be granted by the training Administrator/Coordinator, if 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.

9.7 Daily Training Logbook

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

9.8 Industrial Training Report

An Industrial Training Report will be submitted upon completion of SIT. The Report must describe student's learning and development in technical knowledge, engineering practices and professional skills acquired through practical experience. The Industrial Training Report should also reflect 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.

9.9 Guidelines for Preparation of Industrial Training Report

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

9.9.1 Contents of Industrial Training Report

(a) Table of Contents

This section of the report shall consist of:

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

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

(b) Background & 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 describe fully 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. Major works 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.

9.9.2 Format of the Report

(a) General

i. Students are advised to start writing the SIT Report as soon as training commences to ensure 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

9.10 SIT Assessment

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

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

It is also 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.

9.11 Completion of Industrial Training

i. Upon completion of a 16- or 32-week continuous SIT, a Confirmation Letter to this effect must be obtained from the training organization 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 Biomedical Engineering Technology for bachelor's degree program was held on 14-03-2022 to 16-03-2022 at the Superior University, Lahore.
2. The meeting started with recitation from the Holy Quran by Engr. Prof. Dr. Yaseer Arafat Durrani. The NTC representative, Mr. Hafiz Ghulam Muhammad, welcomed the members and thanked them for attending the meeting, and briefed about the NTC expectations from Committee. All the participants introduced themselves highlighting their qualifications, experience, and areas of expertise. Mr. Hafiz Ghulam Muhammad offered the house to nominate the Convener, Co-Convener and Secretary of the CDC of the Biomedical Engineering Technology. Engr. Prof. Dr. Yaseer Arafat Durrani, Engr. Dr. Ali Raza Jafri, and Engr. Dr. Tasleem Kausar were selected unanimously as Convener, Co-Convener and Secretary, respectively.
3. The Convener Prof. Dr. Yaseer Arafat Durrani, in consultation with the Committee members, distributed the knowledge area-wise courses among the sub-committees keeping in view the experience and expertise in the field. The following Core Committee, along with the four sub-committees were constituted with their separate Conveners and Secretaries to finalize the contents of their respective knowledge area courses. Dr. Ali Raza Jafri as Co-Convener, briefed each Sub-Committee members about the relevant tasks to be completed for contents of their respective knowledge area courses.

S.No	NCRC Members	Role
1.	Prof. Dr. Yaseer Arafat Durrani Professor Chairman, Electronics Engineering & Biomedical Engineering Technology Department, UET, Taxila	Convener
2.	Prof. Dr. Ali Raza Jafri Professor Chairman, Biomedical Engineering Department NED UET, Karachi	Co-Convener
3.	Dr. Tasleem Kausar Assistant professor HoD, Department of Mirpur Institute of Technology, MUST Mirpur, AJ&K	Secretary
4.	Dr. Amjad Ali Associate Professor Chairman, Electrical Engineering Department UET Peshawar Jalozai Campus	Member
5.	Dr. Abdul Rauf Anwar Associate Professor Chairman, Biomedical Engineering Department UET, Lahore, New Campus	Member
6.	Dr. Nida Iqbal Associate Professor Biomedical Engineering Department, New Campus UET, Lahore	Member
7.	Dr. Ishtiaq Ahmad Associate Professor Electrical Engineering Department University of Lahore (UoL), Lahore	Member

S.No	NCRC Members	Role
8.	Dr. Nabeel Ali Khan Professor HoD, Engineering Technology Department Foundation University, Islamabad	Member
9.	Dr. Muhammad Asim Waris Assistant Professor HoD, Biomedical Engineering & Sciences, NUST, Islamabad	Member
10.	Dr. Saif ur Rehman Assistant Professor Department of Electrical Engineering, Superior University, Lahore	Member
11.	Dr. Adnan Yousaf Assistant Professor HoD, Department of Electrical Engineering, Superior University, Lahore	Coopted Member
12.	Dr. Rao Muhammad Asif Assistant Professor Program Incharge Biomedical Engineering Technology Department Superior University, Lahore	Member
13.	Dr. Muhammad Umer Farooq Assistant Professor HoD, Mechanical Engineering Department KFUEIT, Rahim Yar Khan	Member
14.	Dr. Asjad Amin Associate Professor Information and Communication Engineering Islamia University of Bahawalpur (IUB)	Member
15.	Dr. Abdul Mannan Assistant Professor Head, Biomedical Engineering Technology, NFC Institute of Engineering & Technology, Multan	Member
16.	Dr. Yousaf Khan Associate Professor HoD, Electrical Engineering Department, Kohat Campus, UET, Peshawar	Member
15.	Dr. Saad Jawaid Khan Associate Professor Chairperson, Biomedical Engineering Department Ziauddin University, Karachi	Member
16.	Dr. Surat Khan Professor Chairperson, Electrical Engineering Department, BUITEMS, Quetta	Member
17.	Dr. Sumaira Irum Khan Assistant Professor Department of Pharmacy, MUST, AJK	Member
18.	Hafiz Ghulam Muhammad Admin & Account Officer National Technology Council	NTC Rep.

4. After taking charge by the nominated Committee, Convener, Engr. Prof. Dr. Yaseer Arafat Durrani 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 Biomedical Engineering Technology.

5. In continuation of above guidelines, Prof. Dr. Ali Raza Jafri, Co-Convener, Dr. Tasleem Kausar, Co-Secretary highlighted the objectives of curriculum development.

6. Agreed upon objectives were categorized and assigned to Subcommittees, where Honorable Members reviewed, discussed, and submitted the following resolutions:

    - Develop an undergraduate curriculum of Biomedical Engineering Technology which is at par with international standards and in substantial conformity with the Sydney Accord.
    - Clearly define program education objective (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 needs of society.

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

8. After long deliberations, 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 Biomedical Engineering Technology.
9. Furthermore, list of courses (core and elective) and semester wise breakup of courses were also discussed and finalized.

10. Admission/intake criteria was discussed and adopted as defined in NTC Accreditation Manual.

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

12. 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.

13. HEI's that are geared to provide SIT in two semesters can do this in 7th and 8th Semesters.
14. In line with the experience and expertise of NCRC members, list of courses of various domains were distributed among the Sub-Committees.

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

16. The following Core Committee's, along with four Sub-Committees, were constituted with separate Convenors and Secretaries:

Biomedical Engineering Technology Core Committee		
S. No.	**Name**	**Role**
1	Prof. Dr. Yaseer Arafat Durrani	Convener
2	Prof. Dr. Ali Raza Jafri	Co-convener
3	Dr. Tasleem Kausar	Secretary
1. Subcommittee: Biomedical Engineering Technology Computing, Management & Social Sciences		
S. No.	**Name**	**Role**
1	Dr. Yousaf Khan	Convener
2	Dr. Abdul Mannan	Secretary
3	Dr. Adnan Yousaf	Member
2. Subcommittee: Biomedical Engineering Technology Foundation		
S. No.	**Name**	**Role**
1	Dr. Amjad Ali	Convener
2	Dr. Sumaira Irum Khan	Secretary
3	Dr. Surat Khan	Member
5	Dr. Rao Muhammad Asif	Member
6	Dr. Saif ur Rehman	Member
3. Subcommittee: Biomedical Engineering Technology Breadth		
S. No.	**Name**	**Role**
1	Dr. Abdul Rauf Anwar	Convener
2	Dr. Muhammad Umar Farooq	Secretary
3	Dr. Nida Iqbal	Member
4	Dr. Asjad Amin	Member
5	Prof. Dr. Ali Raza Jafri	Member

4. Subcommittee: Biomedical Engineering Technology Depth		
S. No.	**Name**	**Role**
1	Dr. Muhammad AsimWaris	Convener
2	Dr. Tasleem Kausar	Secretary
3	Prof. Dr. Yaseer Arafat Durrani	Member
4	Dr. Saad Jawaid Khan	Member
5	Dr. Ishtiaq Ahmad	Member
6	Prof. Dr. Nabeel Ali Khan	Member

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

18. The first draft was compiled by the Engr. Dr. Tasleem Kausar, Secretary NCRC, and distributed to Members for review.

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

APPENDIX E: Minutes of the Final Meeting of NCRC

1. The second meeting of the NCRC in the discipline of Biomedical Engineering technology for the bachelor's degree program was held on 08-06-2022 to 10-06-2022 at the University of Engineering & Technology, Taxila.

2. The inauguration session was started with recitation of Holy Quran, and chaired by Honorable Vice Chancellor UET, Taxila. He appreciated the efforts by Members, and highlighted their valuable contribution for the national cause in setting standards for quality-education in Biomedical Engineering Technology.

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

4. Mr. Muhammad Fahd Amin, Acting Registrar, NTC with Mr. Hafiz Ghulam Muhammad represented NTC.

5. The following members attended the meeting:

S.No	NCRC Members	Role
1.	Prof. Dr. Yaseer Arafat Durrani Professor Chairman, Electronics Engineering & Biomedical Engineering Technology Department, UET, Taxila	Convener
2.	Prof. Dr. Ali Raza Jafri Professor Chairman, Biomedical Engineering Department NED UET, Karachi	Co-Convener
3.	Dr. Tasleem Kausar Assistant professor HoD, Department of Mirpur Institute of Technology, MUST Mirpur, AJ&K	Secretary
4.	Dr. Amjad Ali Associate Professor Chairman, Electrical Engineering Department UET Peshawar Jalozai Campus	Member
5.	Dr. Abdul Rauf Anwar Associate Professor Chairman, Biomedical Engineering Department UET, Lahore, New Campus	Member
6.	Dr. Nida Iqbal Associate Professor Biomedical Engineering Department, New Campus UET, Lahore	Member
7.	Dr. Ishtiaq Ahmad Associate Professor Electrical Engineering Department University of Lahore (UoL), Lahore	Member
8.	Dr. Nabeel Ali Khan Professor	Member

S.No	NCRC Members	Role
	HoD, Engineering Technology Department Foundation University, Islamabad	
9.	Dr. Muhammad Asim Waris Assistant Professor HoD, Biomedical Engineering & Sciences, NUST, Islamabad	Member
10.	Dr. Saif ur Rehman Assistant Professor Department of Electrical Engineering, Superior University, Lahore	Member
11.	Dr. Adnan Yousaf Assistant Professor HoD, Department of Electrical Engineering, Superior University, Lahore	Coopted Member
12.	Dr. Rao Muhammad Asif Assistant Professor Program Incharge Biomedical Engineering Technology Department Superior University, Lahore	Member
13.	Dr. Muhammad Umer Farooq Assistant Professor HoD, Mechanical Engineering Department KFUEIT, Rahim Yar Khan	Member
14.	Dr. Asjad Amin Associate Professor Information and Communication Engineering Islamia University of Bahawalpur (IUB)	Member
15.	Dr. Abdul Mannan Assistant Professor Head, Biomedical Engineering Technology, NFC Institute of Engineering & Technology, Multan	Member
16.	Dr. Yousaf Khan Associate Professor HoD, Electrical Engineering Department, Kohat Campus, UET, Peshawar	Member
15.	Dr. Saad Jawaid Khan Associate Professor Chairperson, Biomedical Engineering Department Ziauddin University, Karachi	Member
16.	Dr. Surat Khan Professor Chairperson, Electrical Engineering Department, BUITEMS, Quetta	Member
17.	Dr. Sumaira Irum Khan Assistant Professor Department of Pharmacy, MUST, AJK	Member
18.	Hafiz Ghulam Muhammad Admin & Account Officer National Technology Council	NTC Rep.

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

Sr#	Foreign Expert Name	Affiliation
1	Dr. Hussain Rizvi	College of Engineering, University of Texas at Tyler, USA
2	Dr. Tauseef Gulrez	School of Computing, Science and Engineering, Salford Innovation Research Centre (SIRC), UK

7. After the introductory session, deliberations on the agenda of the second meeting formally commenced which was headed by Convener Engr. Prof. Dr. Yaseer Arafat Durrani, Co-Convener Prof. Dr. Ali Raza Jafri, Secretary Dr. Tasleem Kausar.

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

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

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

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

11. The final draft was compiled by Convener Engr. Prof. Dr. Yaseer Arafat Durrani and member Engr. Dr. Amjad Ali.

12. After review by Members and with the approval of Convener Engr. Prof. Dr. Yaseer Arafat Durrani, Co-Convener Prof. Dr. Ali Raza Jafri it was submitted to NTC.

APPENDIX F: Supervised Industrial Training Logbook (Sample Format)

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

Course of Study:
Year/Semester of Study:

Training Start Date:
Training End Date:

Training Organization Details:

Name of Organization:
Address:

Contact Person:
Contact Number:

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

Daily Training Log

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

Training Week: _____

Date	Time	Training Log

Declaration:

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

_____
Student signature with date

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

APPENDIX G: Supervised Industrial Training Report (Sample Format)

Sample table of content for Supervised Industrial Training Report is provided so that students know what is expected of them before submitting SIT Report. Students are encouraged to expand upon the content presented below. A declaration page validating originality of work, duly signed by the student and trainer must be attached at the beginning of the Report.