VIT Vidyalankar Institute of Technology
Accredited A+ by NAAC

Vidyalankar Institute of Technology

An Autonomous Institute affiliated to University of Mumbai

Bachelor of Technology

in

Biomedical Engineering

Second Year Scheme & Syllabus

(As per AICTE guidelines, with effect from Academic Year 2023-24)

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated, and taken forward in a systematic manner. Therefore, autonomy for Vidyalankar Institute of Technology is not merely a transition from pre-cooked syllabi to self-designed curriculum. Autonomy curriculum of the Institute offers required academic flexibility with emphasis on industry requirements and market trends, employability and problem-solving approach which leads to improving competency level of learners with diverse strengths. In line with this, the curriculum framework designed is **Choice-Based Credit and Grading System (CBCGS)**. Number of credits for each category of courses learnt by learners, internships and projects is finalized considering the scope of study and the ability that a learner should gain through the programme. The overall credits and approach of curriculum proposed is in line with AICTE model curriculum.

The curriculum comprises courses from various categories like basic sciences, humanities and social sciences, engineering sciences, general education and branch specific courses including professional electives and open electives. The curriculum has core courses of branch of engineering positioned and sequenced to achieve sequential and integral learning of the entire breadth of the specific branch. These courses are completed by third year of the engineering programme that enables learners to prepare for higher education during their final year. Professional elective courses, that begins from third year of programme, offer flexibility and diversity to learners to choose specialization from a basket of recent developments in their field of technology. The selection of unique professional elective courses based on industrial requirements and organizing them into tracks is a salient feature of this curricula ensuring employability. Open Elective courses cover multi-disciplinary, special skill development, project management and similar knowledge that make learner capable to work in industrial environment.

For holistic development of learners, apart from technical courses, Humanities and Social Science courses develop the required soft-skills and attitude amongst learners. Our curriculum also introduces Social Service Internship and Internship with institutes abroad along with courses like Design Thinking, Wellness - Body, Mind & Spirit, Indian Traditional Knowledge System under General Education category. These general education courses aim to create balance in brain hemispheres and hence improve learners' clarity in thoughts and responses.

Additionally, curriculum provides add-on minor/honours degree that involves field/ domain study. Learner can avail this degree by completing requirement of additional 18 credits. Thus, the academic plan of VIT envisages a shift from summative to formative and competency-based learning system which will enhance learner's ability towards higher education, employability and entrepreneurship.

Chairman, Board of Studies
Department of Biomedical Engineering
Vidyalankar Institute of Technology

Chairman, Academic Council
Vidyalankar Institute of Technology

Second Year B. Tech. Biomedical Engineering **Semester: III**

Course Structure and Assessment guidelines

Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
HS03	Technical and Business Writing Lab	Practical	2	75	-	-	075
BS06	Engineering Mathematics - III	Theory	3	20	30	50	100
BS18T	Human Anatomy & Physiology	Theory	2	15	20	40	075
BS18P	Human Anatomy & Physiology Lab	Practical	1	25	-	25	050
GEXX*	Any GE course	As per course	As per course				
BM04T	Biomedical Transducers and Control Systems	Theory	2	15	20	40	075
BM04P	Biomedical Transducers and Control Systems Lab	Practical	1	25	-	25	050
BM03T	Electronics Circuits and Devices	Theory	2	15	20	40	75
BM03P	Electronics Circuits and Devices Lab	Practical	1	25	-	25	50
BM08T	Python Programming	Theory	2	15	20	40	075
BM08P	Python Programming	Practical	1	25	-	25	050

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESA= End Semester Examination
*Selection based on the subset of GE courses made available by the Institute for the semester.

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Second Year B. Tech. Biomedical Engineering **Semester: IV**

Course Structure and Assessment guidelines

Course		Head of Learning	Credits	Assessment guidelines (Marks)			Total marks (Passing@40% of total marks)
Code	Name			ISA	MSE	ESE	
HS06	Principles of Economics and Management	Theory+ Tutorial	3	15	20	40	075
BS08	Engineering Mathematics-IV	Theory	3	20	20	60	100
BM02	Biomechanics Prosthetics and Orthotics	Theory+ Tutorial	3	40	20	40	100
BM05T	Analytical and Clinical Equipment	Theory	2	15	20	40	075
BM05P	Analytical and Clinical Equipment	Practical	1	25	-	25	050
BM06T	Linear Integrated Circuits	Theory	2	15	20	40	075
BM06P	Linear Integrated Circuits	Practical	1	25	-	25	050
BM07T	Biological Modelling and Simulation	Theory	2	15	20	40	075
BM07P	Biological Modelling and Simulation	Practical	1	25	-	25	050
BM01T	Digital logics design and analysis	Theory	2	15	20	40	075
BM01P	Digital logics design and analysis Lab	Practical	1	25	-	25	050

ISA=In Semester Assessment, MSE= Mid Semester Examination, ESE= End Semester Examination

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Course Name: Technical and Business Writing Lab

Course Code: HS03

Category: Humanities, Social Sciences and Management

Preamble:

The course, Technical and Business Writing, introduces students to the basics of effective writing. Writing, being one of the core pillars of Communication Skills, is a significant aspect of the engineering curriculum. Engineers will encounter a plethora of technical writing tasks in their careers, and their writing needs to be professional. Technical and Business Writing will enable students to draft effective emails and letters, technical proposals and reports, maintain meeting documentation, while actively using contemporary digital writing tools.

Pre-requisites:

NIL

Course Objectives:

Student will be able to:

- To enable learners to gain understanding of writing effective letters, proposals and reports.
- To facilitate learners in developing the skills of participating in meetings.
- To create awareness of strengthening research orientation by reading and paraphrasing technical papers.
- To introduce strategies for drafting documentation required for higher studies.

Course Outcome:

Student will be able to:

CO1: Draft effective letters and emails for various professional and business requirements.
CO2: Collect and compile data in the form of a technical report, and present findings in front of an audience.
CO3: Write technical reviews and instructions and differentiate between various hazard notations.
CO4: Draft persuasive proposals to achieve the desired outcomes.
CO5: Participate in meetings and draft meeting-related documentation like notice, agenda and minutes.
CO6: Write a Statement of Purpose and understand the requirements of a Letter of Recommendation.

Course Scheme:

Contact Hours		**Credits Assigned**
Theory	Practical	Theory + Practical
1	2	2

*****2 hours practical session will be conducted for the entire class together (to discuss the necessary concepts so that students can participate in practical activities in the class and lab).

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	-	075
Practical	50	-	-	

The assessment/evaluation guidelines for the courses of different credits are mentioned. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Business Correspondence	Principles of Correspondence (7 Cs) Parts of a letter and Formats Request for information/permission Enquiry, Reply to Enquiry Letters Complaints, Claims, Adjustment Letters Email writing and etiquette	4
2	Report Writing	Significance, Objectives of Report Writing Types of Reports Language and Style of Reports Formats of Reports Synopsis writing	3
3	Technical Writing	Introduction to Technical Writing Writing Definitions, Instructions, Safety Notations, Descriptions Technical Reviews of gadgets, software and technologies Principles of Scientific Vocabulary Technical Reports & Technical Presentation Paraphrasing Technical Paper (IEEE Format)	3
4	Proposal Writing	Parts of a Proposal and Formats Drafting persuasive proposals	2

Module No.	Module Name	Content	No. of Hours
5	Meetings and Documentation	Strategies for conducting effective meetings (in person/virtual) Note Taking Notice, Agenda, and Minutes of Meeting Business Meeting Etiquettes	2
6	Documentation for Higher Studies	Statement of Purpose Letter of Recommendation	1
Total			**15**

Suggested List of Assignments:

- Draft an email and a reply to that on any one type of letter (Individual)
- Draft a synopsis of the mini-project report (Group)
- Paraphrase a published IEEE Technical Paper (Individual)
- Draft a technical proposal (Group)
- Participate in a mock meeting and prepare notice, agenda, and minutes (Group)
- Draft a Statement of Purpose (for admission to Higher Studies) (Individual)

Suggested List of Practical:

1. Ice Breakers/Elevator Pitch
2. Letter Writing & Email Writing
3. Synopsis Writing
4. Paraphrase a published IEEE Technical Paper
5. Technical Proposal – Discussion and drafting with relevance to domain (application-based)
6. Mock Meeting (Oral + Documentation)
7. Technical Blogs
8. Technical Reviews
9. Drafting Statement of Purpose & LOR
10. Mini Project Presentation

Suggested Online Courses:

1. Courses on Communication offered by Udemy, Coursera, EdX, NPTEL Swayam, TCS iON
2. Writing Skills for Engineering Leaders https://www.coursera.org/programs/vidyalankar-institute-of-technology-coursera-response-program-tysb7/browse?productId=6sk543Q6EeaRqAobOpNSMQ&productType=course&query=technical+and+business+writing&showMiniModal=true
3. Technical Writing https://www.coursera.org/programs/vidyalankar-institute-of-technology-coursera-response-program-

tysb7/browse?productId=4ESRQQpFEea5dwol2CF9Kw&productType=course&query=technical+writing&showMiniModal=true

Reference Books:

1. Raman Meenakshi and Sangeeta Raman, "Communication Skills", OUP, 2016.
2. Murphy Herta, "Effective Business Communication", McGraw Hill, 2017.
3. Locker Kitty, "Business Communication-Building Critical Skills", McGraw Hill, 2013.
4. Lehman Dufrene, Sinha, "BCOM", Cengage Learning, 2020.
5. Stanton Nicky, "Mastering Communication", Palgrave Master Series, 2009.
6. A. Kaul, "Effective Business Communication", Prentice Hall of India, 2015.
7. Monipally, "Business Communication Strategies", Tata McGraw Hill, 2001.
8. Monipally, "The Craft of Business Letter Writing", Tata McGraw Hill, 1997.
9. Lesiker and Petit, "Report Writing for Business", Mc Graw Hill, 1997.
10. R.C. Sharma and Krishna Mohan, "Business Correspondence and Report Writing", Mc Graw Hill, 2017.

Course Name: Applied Mathematics-III

Course Code: BS06

Category: Basic Science (BS)

Preamble:

The objective of the course is to impart the knowledge of Laplace Transform, Inverse Laplace Transform, Fourier Series, Fourier Transforms, Z-Transform and Complex Variable. The course clarifies the concept of transforms and its applications. The course will enable students to learn different transforms of a function, Complex Variable and it will provide with a sound foundation in Mathematics to prepare them for graduate studies in Biomedical Engineering.

Pre-requisites:

Applied Mathematics-I(BS02)
Applied Mathematics-II(BS04)

Course Objectives:

- To understand and apply Laplace and inverse Laplace transform to solve differential equations.
- Understanding the fundamental of Fourier series, Fourier transform, Z-transform, and Complex Variable to solve real world problems.
- To create a strong foundation by studying the basics of Engineering Mathematics and interfacing to various peripherals which will lead to a well-designed based System.
- To provide students with the sound foundation of Mathematics, Science, and Engineering fundamentals necessary to formulate, solve and analyse engineering problems and prepare them for Graduate studies.
- To impart knowledge of interfacing techniques and educate the student in the domain of Biomedical Engineering.

Course Outcomes:

Student will be able to:

CO1: Apply the knowledge of Laplace Transform to find Laplace Transform of a given function and to solve real integrals in engineering problems..
CO2: Apply the knowledge of Inverse Laplace Transform to find Inverse Transform of a given function.
CO3: Find Fourier series of a given periodic functions by decomposing it into sine and cosine series..
CO4: Apply the knowledge to find Fourier Transform for real life problems and complex engineering problems.
CO5: Apply knowledge to find Z-Transform of a given sequence.
CO6: Apply the concept of complex variable to Engineering problems.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	0	3	0

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Laplace Transform	Definition of Laplace transform Laplace Transform (L) of Standard Functions, Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, Multiplication by t, Division by t, Laplace Transform of derivatives and integrals (All Properties are without proofs). Evaluation of integral using Laplace Transform.	8
2	Inverse Laplace Transform	Formulae of Inverse Laplace Transform, Laplace Inverse using partial fraction, Properties of Inverse Laplace Transform, convolution Theorem (without proof).	8
3	Fourier Series	Fourier series of a periodic function in the interval of period 2π, 2L. Half range Sine and Cosine Fourier series, Complex form of Fourier series.	8
4	Fourier Transform	Fourier Transform, Fourier Sine & Cosine Transform. Inverse Fourier transforms.	8
5	Z-Transform	Z-Transform of a sequence, properties (without proof), examples based on properties. Inverse Z-Transform, Binomial method, convolution theorem (without proof).	6
6	Complex variable	Analytic function, C-R equations in polar & cartesian form (without proof), Harmonic function. Finding analytic function if $u\ or\ v\ or\ (u+v)\ or\ (u-v)$ is given, Milne-Thompson method, Orthogonal trajectories.	7
Total			**45**

Text Books:

1. Dr. B. V. Ramana" Higher Engineering Mathematics", Tata McGraw Hill New Delhi, India 2006
2. P. N. Wartikar & J. N. Wartikar " A Test Book of Applied Mathematics, Vol I & II", Vidyarthi Ghriha Prakashan Pune 2005 9th Edition.
3. Kanti B Datta "Mathematical methods of Science and Engineering", Cengage Learning 2012 Edition
4. N. P. Bali and Manish Goyal" A Text Book of Engineering Mathematics", Laxmi Publications 2006 Edition

Reference Books:

1. Dr. B S Grewal, "Higher Engineering Mathematics", Khanna Publication, 44th Edition.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & sons, 10th Edition.
3. C. R. Wylie & L. C. Barrett, "Advanced Engineering Mathematics", Tata McGraw India, 6th Edition.
4. H K Das, "Advanced Engineering Mathematics", S Chand, 22nd Edition.
5. Murray R. Spiegel. "Schaum's Outline of Laplace Transform", Tata McGraw India, 1st Edition.
6. Murray R. Spiegel. "Schaum's Outline of Fourier analysis with applications", Tata McGraw India ,1stEdition.
7. Robert Vich, "Z transform theory and its applications", Springer, 10th Edition.
8. Dr. B S Tyagi, "Function of a Complex variable", Kedar Nath & Ram Nath publication, 2021.

Course Name: Human Anatomy and Physiology

Course Code: BS18T

Category: Basic Science

Preamble:

This course introduces students to the anatomical structures of the human body and their relationship to each other. The course will also offer in-depth understanding of the different physiological processes taking place inside the human body.

Pre-requisites: NIL

Course Objective:

- To understand the anatomical structures of the human body and their relationship to each other.
- To understand the different physiological processes taking place inside the human body

Course Outcomes:

Learner will be able to:

CO1: Explain the organization of the human body, homeostasis and its maintenance, structure and functions of a cell and basic tissues.

CO2: Classify the components of blood and their functions.

CO3: Describe the anatomical parts and physiological processes of the cardiovascular system and respiratory system.

CO4: Elaborate the anatomical parts and physiological processes of the alimentary system & renal system.

CO5: Describe the structure and functions of nervous system, eye and skin along with the secretions and functions of all endocrine glands.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be

approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Cells and Tissues	Levels of structural organization; Homeostasis and its maintenance. Structure and functions of a cell; membrane potentials; Tissues: epithelial, connective, muscle and nervous.	02
02	Blood	Blood: Composition of Blood, blood cells and their functions, haemoglobin; Blood Grouping; Haemostasis.	02
03	Cardiovascular System & Respiratory system	Cardiovascular System: Anatomy of the heart; Heart valves, systemic and pulmonary circulation; Conduction system of the heart; Cardiac action potential, Cardiac cycle; Cardiac output; Blood pressure. Respiratory System: Anatomy of respiratory system; Pulmonary ventilation, lung volumes and capacities; external respiration, internal respiration.	07
04	Alimentary System & Renal System	Alimentary System: Anatomy of the alimentary system; Secretions of different organs of the alimentary system and their main functions. Renal System: Anatomy of the renal system; Functions of kidney (urine formation, electrolyte balance and pH balance); composition of urine; Micturition.	07
05	Nervous System	Divisions of the nervous system (central and peripheral nervous system); Structure and functions of the brain and spinal cord; Reflex actions and reflex arc; Functions of sympathetic and parasympathetic nervous system; Nerve action potential and nerve conduction	07
06	Special Senses and Endocrine System	Structure of the eye; Physiology of vision; Structure and functions of the skin. Endocrine System: All Glands of the endocrine system, their secretions, and functions.	05
Total			**30**

Suggested Online Courses:

1. Course: Animal Physiology by Prof. Mainak Das - IIT Kanpur
   https://nptel.ac.in/courses/102/104/102104058/
2. Human Anatomy courses on edx: https://www.edx.org/learn/human-anatomy
3. Coursera: Anatomy Specialization University of Michigan
   https://www.coursera.org/specializations/anatomy

Textbooks:

1. Ross and Wilson, "Anatomy and Physiology in Health and Illness", ELBS Pub
2. Elaine N Marieb, "Essentials of Anatomy and Physiology", Pearson Education

Reference Books / Articles

1. Guyton, "Physiology of the Human Body", Prism Book
2. William Ganong," Review of Medical Physiology", Prentice Hall Int.
3. Tortora and Grabowski, "Principles of Anatomy and Physiology" Harper Collin Pub.
4. Elaine N Marieb, "Anatomy and Physiology", Pearson

Course Name: Human Anatomy and Physiology Lab

Course Code: BS18P

Category: Core

Preamble:

This course introduces students to the anatomical structures of the human body and their relationship to each other. The course will also offer in-depth understanding of the different physiological processes taking place inside the human body.

Course Objectives:

- To understand the anatomical structures of the human body and their relationship to each other.
- To gain the knowledge of measurement of various physiological parameters of the human body.

Pre-requisites: NIL

Course Outcome:

The students will be able to:
CO1: Demonstrate measurement of blood pressure using occlusive cuff method.
CO2: Apply blood cell counting principles for measuring blood composition.
CO3: Demonstrate the measurement of electrical activity of heart and the related parameters.
CO4: Demonstrate the measurement of various lung volumes and capacities.
CO5: Appropriately utilize laboratory equipment, such as microscopes, general lab ware, and virtual simulations.
CO6: Locate and identify anatomical structures.

Course Scheme:

		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	**ISA**	**MSE**	**ESE**	**Total**
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be

approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments

1. To measure blood pressure using a sphygmomanometer.
2. To find the total red blood cell count using pre-prepared slides.
3. To find the total white blood cell count using pre-prepared slides.
4. To study the conduction system of the heart.
5. To study the twelve-lead electrode scheme and operation of the ECG Machine.
6. To record ECG and measure its various parameters (amplitude, intervals/segment).
7. To record lung volumes and capacities using a spirometer.
8. Visit to the anatomy department of a hospital to view specimens (cardiovascular & respiratory systems).
9. Visit to the anatomy department of a hospital to view specimens (alimentary & renal systems).
10. Visit to the anatomy department of a hospital to view specimen (nervous system).
11. Present a case study on a given disease/abnormality that requires medical instruments for
12. diagnosis/treatment.
13. Present case a study on a given disease/abnormality that requires medical instruments for
14. diagnosis/treatment.

Suggested List of Mini Projects/PBL (to name few):

1. To measure heartbeats using PQRST Waveform of ECG.
2. Case a study on a given disease/abnormality which requires medical instruments for diagnosis/treatment.

Recommended Online Courses:

1. Course: Animal Physiology by Prof. Mainak Das - IIT Kanpur https://nptel.ac.in/courses/102/104/102104058/
2. Human Anatomy courses on edx: https://www.edx.org/learn/human-anatomy
3. Coursera: Anatomy Specialization University of Michigan https://www.coursera.org/specializations/anatomy

Reference Books / Articles

1. Guyton, "Physiology of the Human Body", Prism Book
2. William Ganong, "Review of Medical Physiology", Prentice Hall Int.
3. Tortora and Grabowski, "Principles of Anatomy and Physiology", Harper Collin Pub.
4. Elaine N Marieb, "Anatomy and Physiology" ,Pearson Education

Course Name: Biomedical Transducers and Control Systems

Course Code: BM21401T

Category: Core Engineering

Preamble:

The primary aim of the biomedical engineering is to measure the physiological parameters with a great level of accuracy. This depends on the selection of an appropriate transducer for application. The measurement of physical quantity and processing of measured signal, utilized for control purpose.

This course introduces students to working principles, construction of basic transducers and development of medical instrumentation. It also covers the applications of transducers and sensors in biomedical engineering.

Pre-requisites:

Physics for Biomedical Engineers (BS20T)
Engineering Chemistry(BS16T)

Course Objectives:

- To enable learners to understand the different properties of measuring instruments.
- To enable learners to understand the working principles of transducers.
- To enable learners to understand the different blocks of instrumentation.
- To enable learners to understand the fundamental of control system.

Course Outcomes:

Learner will be able to:
CO1: Describe the different properties of measuring instruments.
CO2: Explain the working principles of displacement transducers and application in diagnosis.
CO3: Understand the working principles different types of temperature transducers and their applications.
CO4: Understand the working biopotential electrodes and mechanism of ionic conduction.
CO5: Explain the working principles of chemical transducers and application in diagnosis.
CO6: Understand the control system components, time and frequency domain analysis techniques.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Introduction to Instrumentation & Measurement	Generalized Instrumentation System, General Properties of Transducer. Static Characteristics: Accuracy, Precision, Resolution, Reproducibility, Sensitivity, Drift, Hysteresis, Linearity, Input Impedance and Output Impedance. Dynamic Characteristics.	6
2	Displacement Transducers	Displacement, motion and Pressure Measurement: (with applications) Resistive: Potentiometers, Strain Gauges and Bridge Circuits. Inductive: Variable Inductance and LVDT Capacitive type, Piezoelectric Transducers. Types of Diaphragms, Bellows, Bourdon Tubes.	6
3	Temperature Transducers	Temperature measurement: Thermistor, thermocouple, resistive temperature detector; IC-based temperature measurement; Radiation sensors.	4
4	Biopotential electrodes	Electrode-electrolyte interface, half-cell potential, polarization, polarizable and non-polarizable electrodes, calomel electrode; Electrode circuit model, electrode-skin interface and motion artefacts, and basic classification of biopotential electrodes	4
5	Chemical Sensors	Blood gas and Acid- Base Physiology, Potentiometric Sensors (pH, pCO2 Electrodes, Amperometric Sensors (pO2), ISFETS, Transcutaneous Arterial O2 and CO2 Tension Monitoring.	4
6	Basics of Control Systems	Control system components, Time response characteristics of control systems. Transfer function concept, pole and zero of transfer function, Stability analysis of control systems, Frequency Response, Bode diagram, Polar Plot and Nyquist Plot, Stability analysis using Nyquist Stability Criterion,	6
Total			**30**

Suggested list of Assignments:

1. Characteristics of measuring instruments.
2. Classification of transducers.
3. Static and dynamic characteristics of measuring systems.
4. Presentation on advanced transducers for displacement, temperature, chemical changes measurement.
5. Poster presentation on analyzing instrumentation system.

Suggested List of Value-Added Home Assignments:

1. Effect of loading effect on measurement of current & voltage.
2. Different types of biopotential electrodes available in the market.
3. Development of basic medical instrumentation system.

Suggested Online Courses:

1. Control engineering
   https://onlinecourses.nptel.ac.in/noc23_ee16/preview
2. Transducers For Instrumentation
   https://onlinecourses.nptel.ac.in/noc23_ee105/preview

Reference Books:

1. A. K. Sawhney, "Electrical Measurements and measuring Instruments", Dhanpat Rai and Sons, 1998
2. T Togawa, T Tamura, P. Ake Oberg, "Biomedical Transducers and Instruments", CRC press, 2011
3. K. Ogata, "Modern Control Engineering", Pearson Education, 2015.
4. I .J. Nagrath & M. Gopal, "Control System Engineering", New Age International Publication, 2009.
5. S. Norman Nishe, "Control system Engineering", John Wiely and Sons, 2000.

Course Name: Biomedical Transducers and Control Systems Lab

Course Code: BM21401P

Category: Core Engineering

Preamble:

The diagnostic sector in medical area is growing very rapidly and new detection modalities are used in effective detection. Hence, it very important to learn and understand the concept of transduction and control for the development of indigenous systems.

This lab enables students to understand the basic blocks of medical instrumentation system, working principles and construction of transducers. It also discusses basics of control system components and analysis of systems.

Pre-requisites:

Physics for Biomedical Engineers (BS20T)
Engineering Chemistry (BS16T)

Course Objectives:

- This course enables students to relate the instrumentation system with real-life automated systems.
- This course will develop the analytical reasoning for static characteristics of measuring instruments.
- This course will make students competent in understanding basic control systems components.
- This course enables learners to understand the usage of different methods in analyzing systems.

Course Outcomes:

Learner will be able to:
CO1: Understand and analyze the static and dynamic properties of measuring instruments.
CO2: Build the basic blocks of medical instrumentation system.
CO3: Classify the different transducers used in biomedical engineering.
CO4: Apply the fundamental knowledge of transducers for selection an appropriate transducer.
CO5: Explain the significance of different techniques used to analyze systems.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested list of Practicals:

1. Measurement of the voltage & current for minimal error to relate the loading effect.
2. Estimation and calculation of errors during measurement.
3. Study the working of Linear Displacement Transducer- Potentiometer
4. To study principle and working of L.V.D.T.
5. To study principle and working of a capacitive sensor.
6. To study the resistance versus temperature characteristics of a thermistor.
7. Simulate the performance of a chemical sensor.
8. To study the transient response of dynamic system
9. Determination of Step response for first order and second order system with unity feedback on CRO and calculation of control system specification: Time constant, percentage peak overshoot, settling time from the response.
10. Determination of Step response and Impulse response for type-0, type-1 and type-2 system with unity feedback using MATLAB/PSPICE.

Suggested Online Courses:

1. Sensors and Transducers https://www.udemy.com/course/sensors-and-transducers/
2. Sensors and Sensor Circuit Design https://www.coursera.org/learn/sensors-circuit-interface

Reference Books:

1. A. K. Sawhney, "Electrical Measurements and measuring Instruments", Dhanpat Rai and Sons, 1998
2. T Togawa, T Tamura, P. Ake Oberg, "Biomedical Transducers and Instruments", CRC press, 2011
3. K. Ogata, "Modern Control Engineering", Pearson Education, 2015.
4. I .J. Nagrath & M. Gopal, "Control System Engineering", New Age International Publication, 2009.
5. S. Norman Nishe, "Control system Engineering", John Wiely and Sons, 2000.

Course Name: Electronic Circuits Analysis and Design

Course Code: BM03T

Category: Core

Preamble:

Electronics circuits are the nerves of all modern equipment that make our life sophisticated. Acquiring the basic knowledge about the principle of operation of semiconductor electronic devices like diodes, transistors and elementary circuits. In this course will enable the students to learn about the use of transistors in analog circuits like single and multistage amplifier and power amplifier. It also gives information about the biasing and analysis of Transistors, which are the essentials needed for Integrated Circuits and their applications in biomedical engineering.

Pre-requisites:

Basic Electrical & Electronics Engineering (ES08T)
Physics for Biomedical Engineering (BS20T)
Applied Mathematics-I(BS02T)

Course Objective:

- To understand transfer characteristics of semiconductor devices and to analyse basic application circuits.
- To make learners aware about the mathematical models of BJT and its use in analysing the circuits.
- To make the learners aware about different types of coupling and the concept of multistage amplifiers.
- Learners will be able to design power amplifier.
- To learn types and applications of MOSFET**.**

Course Outcomes:

Learner will be able to:

CO1: Recall the basic semiconductor components like P-N junction diodes, Zener diodes and their various applications.
CO2: Describe the working of BJT and its various configurations and DC operating conditions
CO3: Explain AC operating conditions and Design of single stage small Signal CE amplifiers.
CO4: Show the working of MOSFETs, its characteristics and its various applications.
CO5: Illustrate the concept of multistage amplifiers.
CO6: Analyse the power amplifier circuits.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Basics of Diodes & Basics of BJT	Construction, Working, Characteristics, and Current Equation & Equivalent circuits of P-N Junction Diode as well as Zener Diode. Applications of Diode: Clipper & Clamper. Construction, Working, Characteristics of 3 different configurations of BJT.	5
02	BJT as an Amplifier	Q-point, DC load line, BJT Biasing techniques (Fixed, Self, Voltage Divider, Collector to base, Collector to base self) and BJT as a switch.A.C. Equivalent Model: re model, h-parameter model (Exact and Approximate) and Hybrid-π model.A.C. Analysis (Using any one model): A.C. load line, A.C. analysis of CE, CB, CC amplifier configurations, Effects of RS & RL and Comparison of various amplifiers. Low frequency and High frequency analysis of Single stage amplifiers. Design of single stage amplifier using BJT.	8
03	Multistage Amplifier	Need of cascading, Types of coupling, cascode amplifier, Darlington amplifier	5
04	Power Amplifiers	Classes of Power amplifiers, Class-A Power Amplifiers (Direct coupled and Transformer coupled), Class-B Power Amplifiers, Crossover distortion, harmonic distortion, Class-AB Push Pull, Complementary Symmetry Power amplifier & Class-C Power Amplifier. Power amplifier design, Heat Sinks and its design.	6
05	MOSFET	Comparison of BJT & FET, Types, Characteristics, biasing of	6

Module No.	Module Name	Module Contents	No. of Hours
		MOSFET, MOSFET as an amplifier & MOSFET as a switch	
Total			**30**

Suggested Online Courses:

1. Introduction to Electronics- https://www.coursera.org/learn/electronics
2. Fundamentals of Audio and Music Engineering: Part 1 Musical Sound & Electronics- https://www.coursera.org/learn/audio-engineering
3. Introduction to Biomedical Engineering- https://www.coursera.org/learn/bioengineering
4. https://www.edx.org/learn/circuits
5. NOC:Analog Electronic Circuits, IIT Kharagpur, Prof. Pradip Mandal

a. https://nptel.ac.in/courses/108105158

Text Books:

1. Donald A Neamen, "Electronic Circuit Analysis and Design" Mc Graw Hill Education
2. Robert Boylestad. Louis Nashelsky "Electronic Devices and circuits".Pearson Education
3. "Semiconductor Data Handbook", BPB Publications.

Reference Books / Articles

1. Martin Roden, Gordon L. Carpenter, William Wieseman "Electronic Design", Fourth edition, Shroff Publishers & Distributors Pvt. Ltd..
2. Donald Schilling & Charles Belove "Electronic Circuits Discrete and Integrated", Third edition, McGraw Hill.
3. Albert Paul Malvino "Electronic Principles" 6th edition, McGraw Hill
4. Jacob Milliman "Electronic Devices and Circuits" by McGraw Hill.

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Course Name: Electronic Circuits Analysis and Design Lab

Course Code: BM03P

Category: Core

Preamble:

Electronics circuits are the nerves of all modern equipment that make our life sophisticated. Acquiring the basic knowledge about the principle of operation of semiconductor electronic devices like diodes, transistors and elementary circuits. In this course will enable the students to learn about the use of diodes and transistors in analog circuits like rectifiers, single & multistage amplifier and power amplifier. It also gives information about the biasing and analysis of Transistors, which are the essentials needed for Integrated Circuits and their applications in biomedical engineering.

Course Objectives:

- To practically verify characteristics of different electronic components like diodes, BJT, MOSFET etc
- To practically verify outputs of few applications of diodes, BJT, MOSFET.
- To design and implement small signal amplifier.

Pre-requisites:

Basic Electrical & Electronics Engineering (ES08P)
Physics for Biomedical Engineering (BS20P)
Applied Mathematics-I(BS02P)

Course Outcome:

The students will be able to:
CO1: Explain the transfer characteristics of basic semiconductor devices
CO2: Design and verify the outputs of various electronic circuits such as clipper clampers etc using bread boards and various lab equipment.
CO3: Design amplifier circuits and plot its frequency response.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his

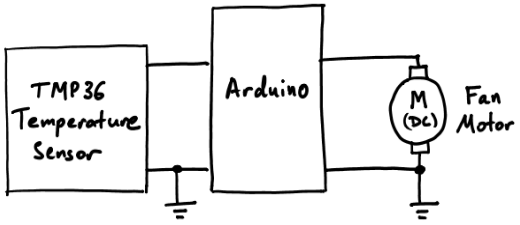
assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments

1. To verify semiconductor diode and Zener diode characteristics.
2. To implement various clipper circuits and verify output.
3. To implement various clamper circuits and verify output.
4. To study line regulation and load regulation of voltage regulator using Zener diode.
5. To verify input and output characteristics of BJT.
6. To implement a switch using BJT.
7. To implementation different biasing circuit of BJT
8. To design and implement CE amplifier.
9. To study frequency response of CE amplifier.
10. To verify input and output characteristics of MOSFET.
11. To implementation different biasing circuit of MOSFET
12. To Study frequency response of an MOSFET amplifier.
13. Implementing CMOS inverter using CMOS.

Suggested List of Mini Projects/PBL (to name few):

1. Frequency Counter Circuit
2. Appliances Security Controller Using Power Line
3. Automatic Sprinkler Control System
4. Half wave and Full wave precision rectifier.
5. Public addressing system
6. Adjustable Voltage Power Supply
7. Rain Alarm Circuit Using Two Transistors
8. Design a switch using BJT which turns on Green LED whenever it comes in close vicinity with a sound source.
9. Design a switch using BJT which turns on Red LED whenever it comes in close vicinity with a Hot object
10. Following system has two majot concerns firstly The TMP36 output voltage range does not match well with Arduino input voltage range and secondly The Arduino does not output enough current to start the motor



Suggest BJT based ciricuits to overcome over concerns.

11. Design an amplifier using BJT to amplify very small electrical signals consider following specifications:
    i. Gain of 150.
    ii. Filter setting: high pass filter of 300 Hz.
    iii. Stability factor to be maintained below 10.
12. Use cascode configuration along with a voltage ladder to form a high-voltage transistor.

Recommended Online Courses:

1. Introduction to Electronics- https://www.coursera.org/learn/electronics
2. Fundamentals of Audio and Music Engineering: Part 1 Musical Sound & Electronics- https://www.coursera.org/learn/audio-engineering
3. Introduction to Biomedical Engineering- https://www.coursera.org/learn/bioengineering
4. https://www.edx.org/learn/circuits
5. NOC:Analog Electronic Circuits, IIT Kharagpur, Prof. Pradip Mandal https://nptel.ac.in/courses/108105158

Reference Books / Articles

1. Martin Roden, Gordon L.Carpenter, William Wieseman "Electronic Design", Fourth edition,Shroff Publishers & Distributors Pvt. Ltd..
2. Donald Schilling & Charles Belove "Electronic Circuits Discrete and Integrated", Third edition,McGraw Hill.
3. Albert Paul Malvino "Electronic Principles" by 6th edition, McGraw Hill
4. Jacob Milliman "Electronic Devices and Circuits" McGraw Hill.

Course Name: Python Programming

Course Code: BM08T

Category: Core

Preamble:

Python is a versatile programming language that finds applications in various engineering fields. As an engineering student, you will find that Python can be a valuable tool in your arsenal for data analysis, simulation, modeling, and automation. This course is designed to equip you with the necessary skills and knowledge to use Python effectively in your engineering projects.

In this course, we will start with the basics of Python programming, including data types, control structures, functions, and modules. We will then progress to more advanced topics such as object-oriented programming, data visualization, and web development using Python frameworks. Additionally, we will introduce you to some of the most popular Python libraries and tools for scientific computing, such as NumPy, SciPy, and Matplotlib, and show you how to apply them to solve engineering problems. By the end of this course, you will have a solid understanding of Python programming and the ability to apply it to your engineering projects, making you a more competent and effective engineer.

Pre-requisites:

Structured Programming (ES04T, ES04P).

Course Objective:

- To understand the fundamental concepts of Python programming,
- To understand the basic data types, control structures, functions, and modules.
- To understand the utilization of various libraries in Python by working with popular Python libraries and tools for scientific computing, such as NumPy, SciPy, and Matplotlib.
- To use Python to solve a range of programming problems and tasks, including data analysis, visualization, and web development.

Course Outcome:

Learner will be able to:
CO1: Describe Numbers, Strings, Lists, Tuples, Dictionaries, Array and Math functions in Python.
CO2: Express different Decision-Making statements and Functions
CO3: Illustrate different file handling operations.
CO4: Interpret object-oriented programming in Python.
CO5: Work with popular Python libraries and tools for scientific computing, such as NumPy, SciPy, and Matplotlib, to analyze and visualize data.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Introduction to Python	Installation and resources; Introduction of the Python object types: Numbers, Strings, Lists, Tuples, Dictionaries, Arrays; Numeric types; Assignments; Expressions; Print statements and formats	5
02	Decision Control Statements and Functions	if and else statement, if-elif-else statement, Loop Statement: While loops, for loops, Break, Continue, and Pass, Functions: Defining and calling functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions.	5
03	Files Handling	Types of Files in Python, Opening a File, Closing a File. Writing Text Files, Knowing Whether a File Exists or Not, Working with Binary Files, Appending Text to a File, Reading Text Files, File Exceptions	5
04	Object Oriented Programming	Introduction, Creating classes and objects., Constructors, Inheritance, and interface	5
05	Numpy, Matplotlib	Introduction to Numpy: Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy. Introduction to Matplotlib library: Line properties, Plots and subplots, Types of Plots.	5
06	Pandas, Seaborn	Introduction to Pandas: Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation. Introduction to Seaborn	5
Total			**30**

Suggested Online Courses:

1. Python Data Science Handbook (GitHub) - https://jakevdp.github.io/PythonDataScienceHandbook/
2. Google's Python Class - https://developers.google.com/edu/python/
3. DataCamp - Introduction to Python - https://www.datacamp.com/courses/intro-to-python-for-data-science

4. Python Programming: A Concise Introduction (Wesleyan University) - https://www.coursera.org/learn/python-programming-introduction
5. Introduction to Python Programming (edX) - https://www.edx.org/course/introduction-to-python-programming

Textbooks:

1. E Balagurusamy, "Introduction to computing and problem-solving using python", McGraw Hill Education.
2. Dr. R. Nageswara Rao, "Core Python Programming", Dreamtech Press.
3. John Grayson, "Python and Tkinter Programming", Manning Publications.
4. Dusty Phillips, "Python 3 object-oriented Programming", Second Edition PACKT Publisher August
5. 2015.
6. Yashavant Kanetkar, "Let us Python: Python is Future, Embrace it fast", BPB Publications; 1
7. edition
8. James Payne, "Beginning Python: Using Python 2.6 and Python 3.1", Wrox publication.

Reference Books / Articles

1. David Beazley, "Python Cookbook: Recipes for Mastering Python 3, Brian K. Jones O'Reilly Media.
2. Zed "Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code",A. Shaw Addison Wesley.
3. Andreas C. Mueller O'Reilly," Introduction to Machine Learning with Python", Third edition
4. Eric Matthes" Python Crash Course A hands-on, Project Based Introduction to programming, second edition.

Course Name: Python Programming lab

Course Code: BM08P

Category: Core

Preamble:

This lab is an extension of the Python course that you have been taking and is designed to give you hands-on experience with Python programming. Through a series of lab exercises, you will have the opportunity to apply the concepts and techniques learned in the course and gain a deeper understanding of how Python can be used in engineering applications.

In this lab, you will work on a range of Python projects that cover topics such as data analysis, simulation, decision making etc. You will also work with popular Python libraries and tools for scientific computing, such as NumPy, SciPy, and Matplotlib, and learn how to apply them to solve engineering problems. Additionally, you will work on mini projects that will help you develop your Python skills further and prepare you for more advanced projects in the future.

Pre-requisites:

Structured Programming (ES04T, ES04P).

Course Objectives:

- To demonstrate the fundamental concepts of Python programming.
- To give examples of the basic data types, control structures, functions, and modules.
- To perform experiments by utilization of various libraries in Python by working with popular Python libraries and tools for scientific computing, such as NumPy, SciPy, and Matplotlib.
- To solve a range of programming problems and tasks, including data analysis, visualization, and web development.

Course Outcome:

Learner will be able to:
CO1: Demonstrate Numbers, Strings, Lists, Tuples, Dictionaries, Array and Math functions in Python.
CO2: Give examples of different Decision-Making statements and Functions.
CO3: Interpret different file handling operations.
CO4: Relate object-oriented programming in Python.
CO5: Work with and demonstrate popular Python libraries and tools for scientific computing, such as NumPy, SciPy, and Matplotlib, to analyze and visualize data.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments

1. Write python programs to understand expressions, variables, quotes, basic math operation.
2. Write a Python program to remove elements from the list.
3. Write a Python program to understand the concept of tuple and dictionary. (Creating, accessing elements, and deleting elements)
4. Write a Python program to demonstrate if-else, for loop and while loop.
5. Write a Python program to demonstrate continue, break and pass statement.
6. Write a Python program to read, write and copy from a file.
7. Write a Python program to demonstrate the working of classes and objects and members.
8. Write a Python program to demonstrate constructors.
9. Write a Python program to demonstrate inheritance.
10. Write a Python program to demonstrate sorting in NumPy.
11. Write a Python program to perform merging, joining and concatenating using Panda.
12. Write a Python program to plot the data using matplotlib

Suggested List of Mini Projects/PBL (to name few):

1. **Weather App:** Build a weather app that displays the current weather conditions for a given location using an API like OpenWeatherMap.
2. **Password Manager:** Develop a password manager that generates and stores secure passwords for different accounts and allows users to retrieve them when needed.
3. **Text Editor:** Create a simple text editor that allows users to create, edit, and save text files.
4. **Sudoku Solver:** Develop a program that solves Sudoku puzzles automatically using backtracking and recursion.
5. **Image Resizer:** Create a program that resizes images and saves them in a different format.
6. **Sentiment Analysis:** Develop a program that performs sentiment analysis on text data using Natural Language Processing techniques and outputs the sentiment score for the text.

Suggested List of Mini Projects/PBL in healthcare (to name few):

1. **Medical Image Analysis:** Develop a program that can analyze medical images such as X-rays, MRIs, and CT scans using Python libraries like scikit-image and OpenCV.

2. **Health Monitoring System:** Build a system that can monitor and track a patient's health using wearable devices and sensors, and alert healthcare providers in case of any abnormalities.
3. **Electronic Health Record (EHR) System**: Create a simple EHR system that can store and retrieve patient medical records, such as lab results, prescription information, and medical history.
4. **Medical Chatbot:** Develop a chatbot that can answer common medical questions, provide basic health advice, and refer patients to relevant healthcare providers or services.
5. **Medical Data Analysis:** Analyze medical data using Python libraries like pandas and NumPy to identify trends and patterns in disease incidence, mortality rates, and healthcare utilization.
6. **Telemedicine Platform:** Build a telemedicine platform that allows healthcare providers to conduct virtual consultations with patients, using video conferencing and messaging features.
7. **Medical Image Segmentation:** Develop a program that can segment medical images to identify specific structures and regions of interest, such as tumors or blood vessels.
8. **Disease Prediction:** Use machine learning algorithms and healthcare datasets to predict the likelihood of certain diseases in patients based on their demographics, medical history, and lifestyle factors.
9. **Automated Diagnosis:** Develop a program that can automatically diagnose certain medical conditions, such as skin diseases, based on images and symptoms.
10. **Prescription Recommender:** Create a program that can recommend the most appropriate medication or treatment for a patient based on their medical condition, health history, and other relevant factors.

Recommended Online Courses:

1. Python for Everybody (University of Michigan) on Coursera: https://www.coursera.org/specializations/python
2. Complete Python Bootcamp: Go from zero to hero in Python 3 on Udemy: https://www.udemy.com/course/complete-python-bootcamp/
3. Python Crash Course: A Hands-On, Project-Based Introduction to Programming by Eric Matthes: https://ehmatthes.github.io/pcc/
4. Learn Python (Codecademy) - https://www.codecademy.com/learn/learn-python
5. Python Data Science Handbook (GitHub) - https://jakevdp.github.io/PythonDataScienceHandbook/
6. Google's Python Class - https://developers.google.com/edu/python/
7. DataCamp - Introduction to Python - https://www.datacamp.com/courses/intro-to-python-for-data-science
8. Python Programming: A Concise Introduction (Wesleyan University) - https://www.coursera.org/learn/python-programming-introduction
9. Introduction to Python Programming (edX) - https://www.edx.org/course/introduction-to-python-programming

Reference Books / Articles

1. David Beazley, "Python Cookbook: Recipes for Mastering Python 3, Brian K. Jones O'Reilly Media.
2. Zed "Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code", Shaw Addison Wesley.
3. Andreas C. Mueller O'Reilly," Introduction to Machine Learning with Python", Third edition

4. Eric Matthes" Python Crash Course A hands-on, Project Based Introduction to programming, second edition.

Course Name: Principles of Economics and Management

Course Code: HS06

Category: Humanities and Social Sciences

Preamble:

The restructured and revised curriculum for the Course is developed considering the current industry needs in terms of skill sets demanded under new business environment. It also endeavors to align the programme structure and course curriculum with student aspirations and corporate expectations.

Pre-requisites:

Nil

Course Objectives:

- To have a basic understanding of various macroeconomic concepts.
- To enable the students to understand both the theory and practice of managerial economics and management.
- To introduce theories and concepts in micro-economics for managerial decision making,
- To help the students in applying the knowledge so acquired in policy planning and managerial decision making.
- To help students to understand human behaviour in organizations and equip them to enhance their performance as well as performance of the people reporting to them.

Course Outcomes:

Learner will be able to:
CO1: To explain the relationships between organizational mission, goals, and objectives.
CO2: To comprehend the significance and necessity of managing stakeholders
CO3: To conceptualize how internal and external environment shape organizations and their responses.
CO4: To develop critical thinking skills in identifying ethical, global, and diversity issues in planning, organizing, controlling and leading functions of management
CO5: To Understand organizational design and structural issues
CO6: To understand that citizenship involves taking conscious steps for societal advancement at individual level and organizational level

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Management Theory and practice	Management: Science, Theory and Practice – The Evolution of Management Functions of Management Nature and purpose of Planning Objectives, Strategies, Policies and Planning Premises – Decision making – Global Planning	5
2	Decision making	Managing your career and understanding organisational dynamics: - Leadership functions and corresponding skills required - Choosing the right positions. Special dilemmas of early career - Landing stretch assignments - Building a network of relationships - Challenges faced by the minority - Developing ethical judgment - Assessing your career	5
3	Crisis Management	Managing in adversities / Management of crisis	5
4	Corporate Social responsibility	Social Responsibility, Ethics and Sustainable Development	5
5	Roled and Responsibilities	Role and Responsibilities of a Manager, Effective and Ineffective Managerial styles	5
6	Strategic Management	Strategic Management – Definition, classes of decisions, levels of decision, Strategy, Role of different Strategists, Relevance of Strategic Management and its benefits, Strategic Management in India	5
Total			**30**

Suggested list of Assignments:

1. Understand how prices get determined in markets, how market participants benefit in the form of consumer surplus and producer surplus, and the consequences of government intervention.
2. Derive the equilibrium conditions for cost minimization and profit maximization.
3. List the different goals and constraints that firms face.

Suggested List of Value-Added Home Assignments:

1. Find out the management practices of various orgnizations like partnership firms, MNC or family managed businesses

Reference Books:

1. DreaZigarmi, Michael O'Connor, Ken Blenchard, Carl Edeburn "The Leader Within", Financial Times/Prentice Hall,9th Edition
2. John Adair, "The Action-Centred Leadership", Gower Pub Co, 1979

Course Name: Applied Mathematics-IV

Course Code: BS08

Category: Basic Science (BS)

Preamble:

This course introduces students to Engineering Mathematics-IV, with detailed Mathematical introduction to Complex Integration, Vector Spaces and Statistical Techniques like Probability Distribution, Correlation and Regression which are widely applicable in Biomedical Engineering. This Course will also offer in-depth understanding of fundamental and theoretical underpinnings, applications, best practices, and research activities.

Pre-requisites:

Applied Mathematics-I(BS02)
Applied Mathematics-II(BS04)
Applied Mathematics-III(BS06)

Course Objectives:

- To understand complex Integration concept and apply to evaluate integrations.
- Understanding the fundamental of linear algebra with advanced matrices and Vector Space, Statistical Techniques like Probability Distribution and Correlation and Regression to solve real world problems.
- To create a strong foundation by studying the basics of Engineering Mathematics and interfacing to various peripherals which will lead to a well-designed based System.
- To provide students with the sound foundation of Mathematics, Science, and Engineering fundamentals necessary to formulate, solve and analyse engineering problems and prepare them for Graduate studies.
- To impart knowledge of interfacing techniques and educate the student in the domain of Biomedical Engineering.

Course Outcomes:

Student will be able to:
CO1: Develop the ability to understand the basics of Complex Integration and Residues.
CO2: Evaluate their Mathematical ideas for solving various properties of Matrices and its Eigen values and Eigen vectors.
CO3: Understand the basics of Vector Spaces used in the field of Machine learning, AI and Data Science.
CO4: Learn the basics of Calculus of Variation and its applications to find extremals of the functional.
CO5: Understand the basics of Probability, Moment generating functions and Probability Distributions.

CO6: Understand the basic statistical techniques Correlation and Regression lines for the field of Data analysis.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
3	-	3	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	20	30	50	100

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Complex Integration	Line Integral, Cauchy's Integral Theorem, Cauchy's Integral formula. Taylor's and Laurent's Series, Zeros, singularity, poles of (z), residues, Cauchy's Residue theorem.	8
2	Linear Algebra: Advance Matrix Theory	Eigen values and Eigen vectors, Properties, Cayley Hamilton theorem (without proof), examples based on verification of Cayley Hamilton Theorem. Function of square matrices e.g., $tan(A)$, A^n, k^A,etc	8
3	Linear Algebra: Vector Spaces	n-dimensional vector space, Norms, Inner product, Cauchy-Schwarz Inequality (with proof). Vector spaces over a real field, Subspaces, Orthonormal basis, Gram-Schmidt process for vectors.	8
4	Calculus of Variation	Euler Lagrange equations (only results for different cases for functional) Isoperimetric problems, Functions involving higher order derivatives, Rayleigh-Ritz method.	7
5	Probability Distributions	Random Variable: Probability distribution for discrete and continuous random variable, Bayes Theorem (without proof) Expectation, Variance, Moment generating function, Probability distributions, Binomial, Poisson, and Normal distributions.	8

Module No.	Module Name	Content	No. of Hours
6	Statistical Techniques	Correlation: Covariance, Karl Pearson's Correlation Coefficient. Spearman's rank correlation coefficient, Regression lines, fitting of curves.	6
Total			**45**

Text Books:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & sons, 10th Edition.
2. Dr. B V Ramana "Higher Engineering Mathematics", Tata McGraw Hill New Delhi, India 2006
3. P N Wartikar and J N Wartikar "*Textbook of Applied Mathematics Volume I & II, Vidyarthi* Ghriha Prakashan Pune 2005 9th Edition.
4. N P Bali and Manish Goyal, "A textbook of Engineering Mathematics", Laxmi Publication 2006.

Reference Books:

1. Dr. B S Grewal, "Higher Engineering Mathematics", Khanna Publication, 44th Edition.
2. C. R. Wylie & L. C. Barrett, "Advanced Engineering Mathematics", Tata McGraw India, 6th Edition.
3. H K Das, "Advanced Engineering Mathematics", S Chand, 22nd Edition.
4. Kenneth Hoffman. "Linear Algebra", Pearson 2018.
5. Seymour Lipschutz, "Schaum's Outline of Linear Algebra", Tata McGraw India, 6th Edition.
6. Seymour Lipschutz,"Schaum's Outline of Probability and Statistics", Tata McGraw India ,1st Edition.
7. T. Veerarajan, "Probability, Statistics and Random processes", Tata McGraw India, 2nd Edition.
8. Robert Weinstock, "Calculus of variation with application to physics and Engineering", Dover
9. Publications, New York, 1st Edition.

Course Name: Biomechanics, Prosthetics & Orthotics

Course Code: BM02

Category: Core

Preamble:

The course will help students to understand the basic definitions, classification and general applications of biomechanics. Students will understand the basics of gait cycle, different types of prosthetics and orthotics devices.

Course Objectives:

- To understand the basics of human gait cycle.
- To gain the knowledge of various types of orthotic and prosthetic devices.

Pre-requisites:

1. Engineering Mechanics (ES02T)
2. Physics for Biomedical Engineers (BS20T)
3. Human Anatomy and Physiology (BS18T)

Course Outcome:

The students will be able to:
CO1: Understand the definition of biomechanics, prostheses orthoses and its classification and design principles.
CO2: Develop a better understanding of how mechanical principles influence human motion during everyday life.
CO3: Student will be able to differentiate different types of artificial limbs.
CO4: Understand the definition of prostheses and orthoses and its design principles.

Course Scheme:

Contact Hours		Credits Assigned
Theory	Tutorial	Theory + Tutorial
02	02	03

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory+ Tutorial	40	20	40	100

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose a revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Force system	Classification of force system. Equilibrium of force system.	2
02	Tissue Biomechanics	Direct shear, bending and torque actions and the corresponding stresses and strains in biological tissues. Stress relaxation and creep. Bone structure & composition, Mechanical properties of bone, Soft connective (skin, tendon, ligaments, etc.) covering structure function, and physiological factors.	8
03	Movement Biomechanics	Study of joints and movements. Anatomical levers, Gait Analysis.	5
04	Joint analysis	Instrumentation for gait analysis: Measurement devices-footswitches, instrumented	5
05	Principles in designing orthoses and prostheses	Principles of three point pressure, total contact, partial weight bearing.	5
06	Classification in prosthetics and orthotics	Lower Extremity orthoses and prostheses, Upper Extremity orthoses and prostheses. Spinal orthoses.	5
Total			**30**

Suggested List of Tutorials

1. To study the concurrent coplanar force system.
2. To study the stress-strain relation of mild steel.
3. To study the classification of human bones.
4. To study different types of joints in human body and joint movements.
5. To study the classification of muscles.
6. To study the human gait cycle.
7. To study the gait cycle parameters.
8. Fabrication of PTB/socket of prosthesis.
9. Fabrication of PTB/socket of orthosis.
10. Prosthetic Rehabilitation

11. Advancements in materials used for Prosthetic Devices

Recommended Online Courses:

1. Mechanics of Human Movement By Prof. Sujatha Srinivasan, IIT Madras
   https://onlinecourses.nptel.ac.in/noc21_me52/preview
2. Assistive Devices,Prosthesis and Orthosis, by Dr Sujatha Srinivasan, IIT Madras.
   http://www.digimat.in/nptel/courses/video/112106248/L47.html

Reference Books / Articles

1. Susan J. Hall “Basic Biomechanics”, MC Graw Hill.
2. Dr. Ajay Bahl and others “Basics of Biomechanics" Jaypee Brothers Medical
3. M. Nordin, V.Frankel “Basic Biomechanics of the Musculoskeletal System” Wolters Kluwer
4. Atlas, C. V. Mosby “Human Limbs and their substitutes”
5. C. V. Mosby, “American Atlas of Orthopedics: Prosthetics”
6. C. V. Mosby, “American Atlas of Orthopedics: Orthotics”
7. Prof Ghista “Biomechanics” Private Publication UAE
8. White and Puyator “Biomechanics” Private Publication UAE

Course Name: Analytical and Clinical Equipment

Course Code: BM05T

Category: Core

Preamble:

This course introduces students to understanding basic principles and the working of analytical and clinical equipment. The skills developed will help students to design and develop health care systems. Studying this course will help students to serve in industry and health care institutions.

Pre-requisites:

Human Anatomy & Physiology (BS18T)
Electronics Circuits and Devices (BM03T)

Course Objective:

- To understand the principles and working of analytical instruments.
- To gain knowledge about the principles and working of blood analysis equipment.
- To learn about different types of infusion pumps and components of drug infusion systems.
- To acquire knowledge about different techniques for measuring lung function and capacity.

Course Outcomes:

Learner will be able to:
CO1: Understand principles of various analytical instruments used in hospital and laboratories.
CO2: Demonstrate the knowledge about various blood cell counting systems and blood gas analyzers.
CO3: Demonstrate the knowledge about various infusion pumps used for drug delivery.
CO4: Understand the basic mechanism of ventilation and analysis of pulmonary functions.
CO5: Understand the basic principles and applications of audiometry techniques.
CO6: Understand the basic principle and working of neonatal monitoring systems.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2+1 (O)	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Analytical Instruments	Colorimeter, Spectrophotometer, Auto Analyzer, Electrophoresis Principles, Chromatography Equipment, ELISA Technique (Reader and Washer).	8
02	Blood cell Counter and Blood Gas Analyzer	Blood cell counter (Coulter and Pico-scale) Blood gas Analyzer principle and working,	6
03	Drug Delivery Systems	Infusion pumps, components of drug infusion systems, syringe and peristaltic pumps, Implantable infusion system (insulin pumps).	4
04	Pulmonary Function Analyzer	Respiration measurement technique: Lung volume and capacities, Spirometry, Pulmonary function measurement, Nitrogen Washout & Helium Dilution Techniques.	4
05	Audiometry Equipment	Basic audiometer, Pure tone and Speech audiometer, evoked response Audiometry, Hearing Aids.	4
06	Foetal and Neonatal monitoring instruments	Cardiotocograph, Methods of monitoring of Foetal Heart rate, Monitoring of labor.	4
Total			**30**

Suggested Online Courses:

1. Infusion Pump Testing (https://www.flukebiomedical.com)
2. INCU II Incubator/Radiant Warmer Analyzer (https://www.flukebiomedical.com)
3. Phototherapy Radiometer/Irradiance Meter (https://www.flukebiomedical.com)

Textbooks:

1. R.S. Khandpur, "Handbook of Biomedical Instrumentation", Prentice Hall of India.
2. J.G. Webster, "Medical Instrumentation: Application and Design", John Wiley.
3. Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer, "Biomedical Instrumentation and measurements", Prentice Hall of India.

Reference Books / Articles

1. Carr-Brown, "Introduction to Biomedical Equipment Technology", Prentice Hall of India.
2. J.G. Webster, "Encyclopedia of Medical Devices and Instrumentation", Prentice Hall of India.
3. Various instruments manuals.
4. Various internet resources.

Course Name: Analytical and Clinical Equipment Lab

Course Code: BM05P

Category: Core

Preamble:

This course introduces students to understanding basic principles and the working of analytical and clinical equipment. The skills developed will help students to design and develop health care systems. Studying this course will help students to serve in industry and health care institutions.

Course Objectives:

- To apply the principles of colorimetry and spectrophotometry to determine the concentration of unknown samples and interpret the results.
- To design and implement regulated power supply and temperature control circuits using appropriate components and test their performance.
- To demonstrate the use of analytical and clinical equipment, such as respiratory rate monitoring ckt, foetal HR monitor, and Audiometer, and understand their role in healthcare.

Pre-requisites:

Human Anatomy & Physiology (BS18T)
Electronics Circuits and Devices (BM03P)

Course Outcome:

The students will be able to:
CO1: Apply the concepts and principles learned in the course to design and conduct an analytical experiment and interpret the results to draw conclusions.
CO2: Design and implement a regulated power supply using appropriate components and test its performance.
CO3: Design and implement circuits for clinical equipment's like temperature control circuit, respiratory rate monitoring circuit etc. and evaluate its accuracy and precision.
CO4: Apply the principles of colorimetry and spectrophotometry to determine the concentration of unknown samples and interpret the results.
CO5: Gain exposure to industry/hospital environments through a visit and understand the role of analytical and clinical equipment in different settings.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments

1. Selection of wavelength for colorimeter and spectrophotometer.
2. Find out the concentration of unknown sample using colorimeter and spectrophotometer.
3. Design and implementation of 6V, 1 Amp regulated power supply.
4. Design and Implementation of temperature controller circuit for Infant Warmer machine.
5. Design and Implementation of respiratory rate monitoring circuit for pulmonary function measurement.
6. Demonstration of foetal heart rate monitor.
7. Study of Testing of hearing ability using Audiometer.
8. Industry or Hospital visit.
9. Any other experiment based on syllabus which will help learner to understand topic/concept.

Suggested List of Mini Projects/PBL (to name few):

1. Design and optimize an ELISA assay to detect a specific protein biomarker in blood or urine samples and analyze the results using a spectrophotometer.
2. Investigate the effects of different drug infusion rates on the blood glucose levels of diabetic patients, using a continuous glucose monitoring system and infusion pumps.
3. Develop a portable spirometry device that can measure lung volumes and capacities in real-time and compare its performance with a clinical spirometer.
4. Evaluate the accuracy and precision of a blood cell counter using Coulter and Pico-scale technologies and determine its applicability in clinical settings.
5. Compare the efficiency and sensitivity of different chromatography techniques, such as high-performance liquid chromatography (HPLC) and gas chromatography (GC), for separating and quantifying complex mixtures of organic compounds.
6. Investigate the role of hearing aids in improving the hearing ability of individuals with hearing loss and design an experiment to measure their performance using a pure-tone audiometer.
7. Develop a fetal monitoring system using cardiotocograph and analyze the variations in fetal heart rate and uterine contractions during labor.
8. Design an experiment to measure the respiratory rate and lung function of healthy individuals during exercise, using nitrogen washout and helium dilution techniques.

Recommended Online Courses:

Virtual Labs: https://vlab.amrita.edu/index.php?sub=2&brch=190
Virtual Labs: https://ccnsb06-iiith.vlabs.ac.in/
Virtual Labs: https://mas-iiith.vlabs.ac.in/

Reference Books / Articles

1. R.S. Khandpur, "Handbook of Biomedical Instrumentation", Prentice Hall of India.
2. J.G. Webster, "Medical Instrumentation: Application and Design", John Wiley.
3. Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer, "Biomedical Instrumentation and measurements", Prentice Hall of India.
4. Carr-Brown, "Introduction to Biomedical Equipment Technology", Prentice Hall of India.
5. J.G. Webster, "Encyclopedia of Medical Devices and Instrumentation", Prentice Hall of India.

Course Name: Linear Integrated Circuits

Course Code: BM06T

Category: Core

Preamble:

The term integrated circuit reflects the capabilities of semiconductor industry to fabricate complex electronic circuit consisting of a large number of components on a single substrate. The operational amplifier is the most versatile active element amongst the linear ICs. The course covers the basic principles of Linear Integrated Circuit and Operational Amplifiers in particular their analysis, design and applications.

Pre-requisites:

Basic Electrical & Electronics Engineering (ES08T)
Physics for Biomedical Engineering (BS20T)
Electronic Circuits and Devices (BM03T)

Course Objective:

- To provide concepts of operational amplifier (Op-Amp) with their applications and design methodology.
- To cover analysis of circuits using various ICs.
- To design and develop various circuits for biomedical applications and to develop analytical thinking of students.

Course Outcomes:

Learner will be able to:
CO1: Demonstrate basics of operational amplifiers.
CO2: Analyse different types of Op-Amp based circuits.
CO3: Analyse and design operational amplifier to perform mathematical operations.
CO4: Design operational amplifier-based oscillators.
CO5: Describe various waveform generation IC's and their applications and use it in projects.
CO6: Apply the knowledge of various special function IC's and special purpose diodes for designing of practical applications.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Introduction to Operational Amplifier (Op-Amp):	Introduction to Differential Amplifier. Introduction to an Ideal Operational Amplifier, Block Diagram, DC & AC Characteristics and Equivalent circuit of Op-amp. Op-amp IC 741 characteristics, frequency response and concept of virtual ground.	5
02	Linear Application of Op-Amp	Adder, Subtractor /differential Amplifier, Voltage follower, Integrator (Ideal and practical), Differentiator (Ideal and practical), Instrumentation amplifier and Instrumentation amplifier IC (AD620).Voltage to Current and Current to Voltage converters.	5
03	Non-Linear Applications of operational Amplifier	Voltage comparators, zero crossing detector and Schmitt Trigger (Regenerative comparator).Active Half wave rectifiers, Active Full wave rectifier, Clipper, Clampers, Log and Antilog amplifiers, Sample & hold circuits, Peak detector, Peak to Peak detector and Generalized Impedance Convertor. Introduction to additional Op-Amp ICs and their features: CA3140E, TL081CN, TL061CP, TL071CP, MC33171N, TL0xx, MCP601 and OPA602.	8
04	Oscillators using Operational Amplifier	Concepts of feedback, types of feedback and various topologies of negative feedback.Concepts of Oscillation and Barkhausen's criteria for an oscillator.Types of oscillators: RC Phase shift Oscillator, Wien Bridge oscillator, Colpitt's Oscillator, Hartley Oscillator, Crystal Oscillator and Clapp Oscillator (For all the above oscillators; working, Frequency of oscillation, condition for sustained oscillation and design of each oscillator).	6
05	Special Function ICs	IC 555 Functional Block diagram and Circuit diagram. IC 555 in Astable Multivibrator(AMV) functional diagram, circuit diagram with applications. IC 555 in Monostable Multivibrator (MMV) functional diagram, circuit diagram with applications.	6

Module No.	Module Name	Module Contents	No. of Hours
		Function Generator (IC 8038 or equivalent) Circuit diagram and its applications. VCO (IC 566) Circuit diagram and applications. F-V convertors and V-F convertors Circuit diagram and its applications.	
Total			**30**

Suggested Online Courses:

1. Introduction to Electronics- https://www.coursera.org/learn/electronics
2. Fundamentals of Audio and Music Engineering: Part 1 Musical Sound & Electronics- https://www.coursera.org/learn/audio-engineering
3. Introduction to Biomedical Engineering- https://www.coursera.org/learn/bioengineering

Text Books:

1. Donald A Neamen, "Electronic Circuit Analysis and Design"
2. R Bolystead "Electronic Devices and circuits ".
3. R. Gayakwad "Op-Amps and linear integrated circuits"–
4. D.Roy Chaudhary "Linear Integrated Circuits"

Reference Books / Articles

1. Millman & Halkias "Integrated Electronics"
2. James Fiore "Op-amps and linear integrated circuits, Theory and Applications"
3. https://circuitdigest.com/electronic-circuits/555-timer-monostable-circuit-diagram.

Course Name: Linear Integrated Circuits Lab

Course Code: BM06P

Category: Core

Preamble:

The term integrated circuit reflects the capabilities of semiconductor industry to fabricate complex electronic circuit consisting of a large number of components on a single substrate. The operational amplifier is the most versatile active element amongst the linear ICs. The course covers the designing various linear/nonlinear applications using Op-amp ICs and Timer IC 555 .

Pre-requisites:

Basic Electrical & Electronics Engineering(ES08T)
Physics for Biomedical Engineering(BS20T)
Electronic Circuits and Devices(BM03T)

Course Objectives:

- To study op-amp parameters and understand the data sheet
- To provide designing methodologies for basic circuits like amplifiers, filters, and oscillators etc. using operational amplifiers.
- To implement the circuits on bread boards for verifying the outputs and obtain frequency response.

Course Outcome:

The students will be able to:
CO1: Read the data sheet of different ICs; compare the parameters to select appropriate IC
CO2: To design and implement various building blocks of different biomedical instruments.
CO3: Understand various waveform generation IC's and their applications and use it in projects.
CO4: Apply the knowledge of various special function IC's and special purpose diodes for designing of practical applications.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	050

The assessment/evaluation guidelines for the courses of different credits are mentioned in the above table. Notwithstanding the above, each course faculty shall have the choice to decide her/his assessment methodology based on the nature of the course. Faculty may propose the revised assessment methodology for his/her course. However, the revised assessment methodology shall be approved by a panel constituted at institute level and published to the learners before the commencement of the semester.

Suggested List of Experiments

1. To study op-amp parameters.
2. To design and verify outputs of inverting amplifier, noninverting amplifier and voltage follower.
3. Design and verify the outputs of adder and subtractor.
4. To design and verify output of instrumentation amplifier.
5. To study frequency response of an integrator
6. To study frequency response of differentiator.
7. To study peak detector circuit.
8. To study half wave rectifier and full wave rectifier.
9. To study RC-phase shift oscillator.
10. To study Wein bridge oscillator.
11. To study comparators and zero crossing detector.
12. To design and study band pass filter using op-amp
13. To design and study notch filter.
14. To study monostable multivibrator using IC 555
15. To study astable multivibrator using IC555
16. To verify outputs of IC 8038

Suggested List of Mini Projects/PBL (to name few):

1. Electronics Thermometer Using Op-amp 741 IC
2. Sound detector circuit using op-amp 741
3. Tone Control for Guitar Amplifier Using 741
4. Half wave and Full wave precision rectifier.
5. Adjustable Ripple-Regulated Power Supply Using 741
6. Motion Detector Using NE555 Timer
7. Sound Operated Timer
8. 555 Timer PWM Audio Amplifier
9. Touch-Free Timer Switch
10. Infrared Remote Control Timer
11. Signal Generator and Inverter Using NE555 Timers
12. AC Lamp Blinker Using Timer 555
13. RGB Bulb Using NE555 Timer
14. False Triggering Eliminator for Timer 555

Recommended Online Courses:

Course: Integrated Circuits, MOSFETs, Op-Amps and their Applications by Prof. Hardik Jeetendra Pandya – IISc Bangalore https://nptel.ac.in/courses/108/108/108108111/

Reference Books / Articles

1. Tony Chan Carusone, David Johns, Kenneth William Martin "Analog Integrated Circuit Design", Wiley, 2012
2. James Fiore Delmar "Op-amps and linear integrated circuits, Theory and Applications", Thomson Learning, 2001

Course Name: Biological modelling and simulation

Course Code: BM21404T

Category: Core Engineering

Preamble:

Modern biomedicine is becoming increasingly sophisticated. In order to understand and forecast the trajectory of pathophysiology, illness genesis, and disease dissemination in support of clinical and policy decisions, modelling and simulation have so grown in importance.

This course provides in-depth knowledge of modelling of physiological systems and also helps to understand basic concepts of modelling for designing any physiological systems.

Pre-requisites:

1. Human Anatomy and Physiology (BS18T)
2. Applied Mathematics III(BS06)

Course Objectives:

- To enable learners to understand the process of physiological modelling.
- To enable learners to understand the biophysical laws.
- To enable learners to understand the different models of physiological systems.
- To enable learners to understand the importance of modelling and simulation.

Course Outcomes:

Learner will be able to:
CO1: Describe the process of physiological modelling.
CO2: Explain the biophysical laws in order to build a model.
CO3: Compare the different physiological models & classify.
CO4: Relate the development stages in physiological modelling.
CO5: Apply the simulation tools to build a model.
CO6: Summarize the importance of modelling and simulation.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	75

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Content	No. of Hours
1	Physiological Modelling:	Steps in Modelling, Purpose of Modelling, lumped parameter models, distributed parameter models, compartmental modelling, modelling of circulatory system and respiratory system.	4
2	Model of Neurons:	Biophysics tools, Equilibrium in a one ion system, Donnan Equilibrium, Space-Charge Neutrality, Membrane with no-zero permeability, GHK equation, Active Transport (Pump), Action Potential, Electrical Equivalent model of a biological membrane, The H-H model, Channel Characteristics, Simulation of action potential, voltage propagation in a passive axon (cable equation).	8
3	Neuromuscular System:	Modelling of Stretch reflex, Reciprocal innervations, two control mechanism, Spindle receptor and Golgi tendon bodies, Parkinson's syndrome.	6
4	Cardiovascular Physiology modelling:	Electrical activity of the Heart, Basics of cardiac electrophysiology, generation and propagation of action potentials, overview of cardiac conduction system, Modelling approaches for cardiovascular pathologies and its applications.	4
5	Eye Movement Model:	Eye movements, quantitative eye movement models, techniques for validating models, validation of other physiological systems	4
6	Thermoregulatory systems:	Thermoregulatory mechanisms, model of thermoregulatory system, controller model, validation and application.	4
Total			**30**

Suggested list of Assignments:

1. Model of Neuron.

2. Quantitative eye movement model.
3. Model for prediction of Cardiac Arrhythmia.
4. Presentation on recent simulation tools.
5. Poster presentation on physiological models.

Suggested List of Value-Added Home Assignments:

1. Reviewing Literature in the form of a technical paper.
2. Novel technical paper writing based on review.
3. Creation of a Wikipedia page.

Suggested Online Courses:

1. Introduction to Bioelectricity https://www.edx.org/course/introduction-to-bioelectricity
2. Synapses, Neurons and Brains offered by Hebrew University of Jerusalem https://www.coursera.org/learn/synapses

Reference Books:

1. A.Teri Bahil. "Bioengineering, Biomedical, Medical and Clinical Engineering", Prentice-Hall, Englewood Cliffs, N.J., ©1981
2. Suresh R Devasahayam "Signals and systems in Biomedical Engineering.",Springer
3. Barr and Plonsey "Bio-Electricity A quantitative approach", Springer Science & Business Media, 09-Mar-2013
4. Bronzino "Biomedical Engineering Handbook", CRC Press

Course Name: Biological Modelling and Simulation lab

Course Code: BM21404P

Category: Core Engineering

Preamble:

Biological models can be complex and difficult to understand without practical application. Practical sessions allow students to visualize and understand these models better by applying them to real-world situations. The purpose of this lab is to provide you with hands-on experience in applying theoretical concepts to real-world situations using simulation software

This lab enables students to understand principles and mechanisms underlying biological systems, as well as improved skills in simulation, and problem-solving.

Pre-requisites:

Human anatomy and physiology.(BS18P)

Course Objectives:

- This course enables students to relate the theoretical concepts to real-world situations.
- This course will develop the analytical skills to interpret the data.
- This course will make students competent in understanding the various physiological models
- This course enables learners to understand the importance of simulation of physiological systems.

Course Outcomes:

Learner will be able to:
CO1: Understand to simulate the biological systems.
CO2: Apply theoretical concepts to real-world scenarios using simulation software.
CO3: Classify the different types of Physiological models.
CO4: Analyze the large amount of data and interpret the results accurately.
CO5: Explain the significance of physiological modelling in healthcare.

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Practical	25	-	25	50

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested list of Practicals:

1. Biophysical modelling of neurons involved in chronic pain.
2. A Whole-Body Thermal Model of Man during Hyperthermia.
3. A model for human ventricular tissue.
4. Predictive model for detection of cardiac arrhythmia.
5. Blood Glucose Response to Stress Hormone Exposure in Healthy Man and Insulin Dependent Diabetic Patients: Prediction by Computer Modelling.
6. Modelling and measurement of tracheal sounds.
7. Cellular Level Electrophysiological Modeling and Simulation of Heart Failure.
8. Development of clinician-friendly software for musculoskeletal modelling and control.

Suggested Online Course:

LabView : A creative approach to a real world problem
https://alison.com/course/labview-a-creative-approach-to-a-real-world-problem?utm_source=google&utm_medium=cpc&utm_campaign=PPC_Tier-4_First-Click_Courses-_Broad_&utm_adgroup=Course-3654_LabVIEW:-A-Creative-Approach-to-a-Real-World-Problem&gclid=EAIaIQobChMIqKLM__LW_gIVJFcPAh0Ihg4sEAAYAiAAEgL_L_D_BwE

Reference Books:

1. A.Teri Bahil. “Bioengineering, Biomedical, Medical and Clinical Engineering”, Prentice-Hall, Englewood Cliffs, N.J., ©1981
2. Suresh R Devasahayam “Signals and systems in Biomedical Engineering.”,Springer
3. Barr and Plonsey “Bio-Electricity A quantitative approach”, Springer Science & Business Media, 09-Mar-2013
4. Bronzino “Biomedical Engineering Handbook”, CRC Press

Course Name: Digital Logics Design and Analysis

Course Code: BM01T

Category: Core

Preamble:

Most of the Medical Electronic devices are using digital technology and basic understanding of digital logic design is essential for Biomedical Engineering students
This course introduces students to digital Logic Design, with detailed technical introduction to two widely methods of digital design-Combinational and Sequential design. Course will also offer in-depth understanding of theoretical concepts, hands on trainings and applications

Pre-requisites:

1. Basic Electrical Engineering (ES08T)
2. Electronics Circuits and Devices (BM03T)

Course Objective:

- To make learner aware of basics of Digital circuits, logic design, various Logic Families and Flip-flops.
- Learner should be able to design of various counters, registers and their applications.
- Learner should be able to design sequential circuits as a state machine.

Course Outcomes:

Learner will be able to:

CO1: Describe various number systems, logic gates and logic families.
CO2: Apply Boolean algebra, K-maps for Logic reduction and implementations in SOP and POS form.
CO3: Develop combinational circuits using logic gates, multiplexers, de-multiplexers, and decoders.
CO4: Design synchronous and asynchronous counters using flip flops.
CO5: Design of synchronous sequential circuit as state machine

Course Scheme:

Contact Hours		**Credits Assigned**	
Theory	Practical	Theory	Practical
2	-	2	-

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	15	20	40	075

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Detailed Syllabus:

Module No.	Module Name	Module Contents	No. of Hours
01	Fundamentals of Digital Design:	Introduction, Number system, Binary, Octal, Hexadecimal and other. Conversion from One system to another. Binary Codes: Weighted, Reflective, Sequential, Gray, Error detecting codes, Odd, Even parity, Hamming Codes etc	4
02	Logic Families	TTL,CMOS logic Families and Comparison	2
03	Combinational Logic Design:	Boolean Algebra: Laws of Boolean algebra, De- Morgan's theorems, Relating a Truth Table to a Boolean Expression, Multilevel circuits. Logic Reduction Techniques: K-MAPS and their use in specifying Boolean Expressions, Prime implicant, Minterm, Maxterm, SOP and POS Implementation. Implementation of logic function using universal gates. Application of gray code, Hazards in combinational circuits	6
04	MSI Combinational Circuits:	Elementary designs: Designing code converter circuits Binary Arithmetic circuits: Adder, Subtractor, Magnitude Comparators, Arithmetic Logic Units.Use of Multiplexers in Logic Design: Multiplexer (ULM) Shannon's theorem. De- Multiplexers, Line decoders.	8
05	Fundamentals of Sequential Logic Circuits	Flip-Flops: Comparison of Combinational & Sequential Circuits, Flip-Flops,Converting one Flip-Flop to another Counters: Modulus of a counter, designing synchronous and asynchronous counter using flip flop. Minimum cost and minimum risk approach in design. Designs: Design of sequential circuits as a Mealy and Moore model, basic design of sequence detector. Registers: Working and applications of shift registers	10
Total			**30**

Suggested Online Courses:

- Digital Systems: From Logic Gates to processors offered by University of Barcelona https://www.coursera.org/learn/digital-systems
- Hardware Security-University of Maryland https://www.coursera.org/lecture/hardware-security/introduction-sqYzy

Suggested List of Value-Added Home Assignments:

1. Design of automatic Springler system
2. Hospital Patient flow automation
3. Patient data collection
4. Problem Based Assignment

Text Books:

1. R.P.Jain, "Modern Digital Electronics," Tata McGraw Hill, 1984
2. M Morris Mono, "Digital Design," Prentice Hall International-1984.
3. Digital Design using VHDL Volonoi Pedroni
4. Malvino & Leach, "Digital Principal and Applications", Tata McGraw Hill, 1991.
5. Malvino, "Digital Electronics", Tata McGraw Hill, 1997.
6. John Yarbourugh, "Digital Logic: Applications and Design", Cengage Learning
7. A. Anand Kumar, " Fundamentals of Digital Circuits", Prentice-Hall of India Pvt.Ltd;
8. John F. Wakerly, " Digital Design: Principles & Practices", Prentice Hall

Course Name: Digital Logics Design and Analysis Lab

Course Code: BM01P

Category: Core

Preamble:

Most of the Medical Electronic devices are using digital technology and basic understanding of digital logic design is essential for Biomedical Engineering students
This course introduces students to circuit design in digital Logic, with introduction to practical approaches in two widely methods of digital design-Combinational and Sequential design. Course will also offer hands on trainings and miniprojects

Pre-requisites:

1. Basic Electrical Engineering (ES08P)
2. Electronics Circuits and Devices (BM03P)

Course Objective:

- To make learner design basics Digital circuits, using logic gates
- Learner should be able to implements circuits like various counters, registers and their applications.
- Learner should be able to implement sequential circuits as a state machine.

Course Outcomes:

Learner will be able to:
CO1: Design and implement digital circuits using logic gates.
CO2:. Implement combinational circuits using logic gates, multiplexers, de-multiplexers, and decoders.
CO3: Implement synchronous and asynchronous counters using flip flops.
CO4: Design and implement synchronous sequential circuit as state machine.

Course Scheme:

Contact Hours		Credits Assigned	
Theory	Practical	Theory	Practical
-	2	-	1

Assessment guidelines:

Head of Learning	ISA	MSE	ESE	Total
Theory	25	-	25	050

The assessment guidelines for the courses of different credits are mentioned above. Notwithstanding the above, each course faculty shall have the choice to propose her/his assessment methodology based on the nature of the course. However, the proposed assessment methodology shall be approved by a panel constituted at Institute level and published to the learners before the commencement of the semester.

Suggested list of practicals:

1. To design binary to gray code converter and gray to binary converter.
2. To design parity generator and parity checker circuits.
3. To design adder and subtractor circuits.
4. To design various circuits using multiplexers.
5. To design various circuits using de-multiplexer.
6. To design Asynchronous counter.
7. To design decade counter
8. To design Synchronous counter.
9. To implement shift register and ring counter using MSI shift register.
10. To implement Moore/ Mealy machine.

Suggested list of Miniprojects:

Implementation of digital circuits as state machines

Suggested Online Courses:

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