Biomedical Engineering (BM)

III Semester

TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES			
Course Code (BSc)	**21MAT 31**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives: The goal of the course Transform Calculus, Fourier series and Numerical techniques 21MAT 31 is

- To have an insight into solving ordinary differential equations by using Laplace transform techniques
- Learn to use the Fourier series to represent periodical physical phenomena in engineering analysis.
- To enable the students to study Fourier Transforms and concepts of infinite Fourier Sine and Cosine transforms and to learn the method of solving difference equations by the z-transform method.
- To develop proficiency in solving ordinary and partial differential equations arising in engineering applications, using numerical methods

Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and Provide real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students for group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways:
   - As an introduction to new topics (pre-lecture activity).
   - As a revision of topics (post-lectureactivity).
   - As additional examples (post-lectureactivity).
   - As an additional material of challenging topics (pre-and post-lecture activity).
   - As a model solution for some exercises (post-lecture activity).

Module-1: Laplace Transform

Definition and Laplace transforms of elementary functions (statements only). Problems on Laplace's Transform of $e^{at}f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$. Laplace transforms of Periodic functions (statement only) and unit-step function – problems.

Inverse Laplace transforms definition and problems, Convolution theorem to find the inverse Laplace transforms (without Proof) problems. Laplace transforms of derivatives, solution of differential equations.

Self-study: Solution of simultaneous first-order differential equations.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2: Fourier Series

Introduction to infinite series, convergence and divergence. Periodic functions, Dirichlet's condition. Fourier series of periodic functions with period 2π and arbitrary period. Half range Fourier series. Practical harmonic analysis.

Self-study: Convergence of series by D'Alembert's Ratio test and, Cauchy's root test.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3: Infinite Fourier Transforms and Z-Transforms

Infinite Fourier transforms definition, Fourier sine and cosine transforms. Inverse Fourier transforms, Inverse Fourier cosine and sine transforms. Problems.
Difference equations, z-transform-definition, Standard z-transforms, Damping and shifting rules, Problems. Inverse z-transform and applications to solve difference equations.
Self-Study: Initial value and final value theorems, problems.
(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4: Numerical Solution of Partial Differential Equations

Classifications of second-order partial differential equations, finite difference approximations to derivatives, Solution of Laplace's equation using standard five-point formula. Solution of heat equation by Schmidt explicit formula and Crank-Nicholson method, Solution of the Wave equation. Problems.
Self-Study: Solution of Poisson equations using standard five-point formula.
(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5: Numerical Solution of Second-Order ODEs and Calculus of Variations

Second-order differential equations - Runge-Kutta method and Milne's predictor and corrector method. (No derivations of formulae).
Calculus of Variations: Functionals, Euler's equation, Problems on extremals of functional. Geodesics on a plane, Variational problems.
Self Study: Hanging chain problem
(RBT Levels: L1, L2 and L3)

Course outcomes: After successfully completing the course, the students will be able :

- To solve ordinary differential equations using Laplace transform.
- Demonstrate the Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- To use Fourier transforms to analyze problems involving continuous-time signals and to apply Z-Transform techniques to solve difference equations
- To solve mathematical models represented by initial or boundary value problems involving partial differential equations
- Determine the extremals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)
First test at the end of 5th week of the semester
Second test at the end of the 10th week of the semester
Third test at the end of the 15th week of the semester
Two assignments each of **10 Marks**
First assignment at the end of 4th week of the semester
Second assignment at the end of 9th week of the semester
Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
At the end of the 13th week of the semester
The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**
(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

The question paper will have ten questions. Each question is set for 20 marks.

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books:

1. **B.S. Grewal**: "Higher Engineering Mathematics", Khanna publishers, 44th Ed.2018
2. **E.Kreyszig**: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed. (Reprint), 2016.

Reference Books

1. **V. Ramana:** "Higher Engineering Mathematics" McGraw-Hill Education, 11th Ed.
2. **Srimanta Pal & Subodh C. Bhunia:** "Engineering Mathematics" Oxford University Press, 3rd Reprint, 2016.
3. **N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" Laxmi Publications, Latest edition.
4. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co.Newyork, Latest ed.
5. **Gupta C.B, Sing S.R and Mukesh Kumar:** "Engineering Mathematic for Semester I and II", Mc- Graw Hill Education(India) Pvt. Ltd2015.
6. **H.K.Dass and Er. Rajnish Verma:** "Higher Engineering Mathematics" S.Chand Publication (2014).
7. **James Stewart: "**Calculus" Cengage publications, 7th edition, 4th Reprint 2019.

Web links and Video Lectures (e-Resources):

- http://.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- http://www.bookstreet.in.
- VTU e-Shikshana Program
- VTU EDUSAT Program

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes
- Assignments
- Seminars

III Semester

ANALOG ELECTRONIC CIRCUITS			
Course Code (IPCC)	**21EI/BM32**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	4	Exam Hours	03

Course objectives: This course will enable the students to

- Describe the types of BJT/ FET biasing, and Demonstrate the use of BJT/FET amplifiers
- Understand the modeling of BJT/FET for analysis and to design of BJT/FET Amplifiers
- Understand and Demonstrate Generalized Frequency response of BJT and FET amplifiers.
- Design and analyze Power amplifier circuits.
- Understand the concept of Feedback and its effect on amplifier circuits and Oscillator circuits.
- Understand the basics of Power Electronic systems

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1.Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2.Show Video/animation films to explain evolution of communication technologies.
3. Encourage collaborative (Group) Learning in the class
4.Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
5.Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6.Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
7.Discuss how every concept can be applied to the real world - and when that's possible, it helps to improve the students' understanding.

MODULE-1

DC Biasing – BJT's

Introduction, operating point, Fixed-bias configuration, Emitter-bias configuration, Voltage-divider biasing, Emitter follower configuration. Relevant numerical problems.

DC Biasing – FET's

Introduction, Fixed-bias configuration, Self-bias configuration, Voltage-divider biasing, Relevant numerical problems.

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **Self-study topics:** Collector feedback bias, Transistor switching networks, Bias stabilization **RBT Level:** L1, L2, L3

MODULE-2

BJT AC Analysis

BJT modeling, re transistor model: Common Emitter fixed bias configuration, Voltage-divider bias, CE Emitter-bias configuration (Excluding P-spice Analysis), Emitter follower configuration, Cascaded Systems. The Hybrid equivalent model, Approximate Hybrid equivalent circuit, Fixed bias configuration, Voltage-divider configuration, Hybrid π model

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **Self-study topics:** Design of Common Emitter RC coupled amplifier circuits. **RBT Level:** L1, L2, L3

MODULE-3

FET Amplifiers

Introduction, JFET Small signal model, JFET AC equivalent circuit, Fixed- bias configuration, Self-bias configuration (with bypassed Rs only), Voltage-divider bias configuration, Source follower configuration.

BJT and JFET Frequency Response:

Introduction, General Frequency Considerations, Low Frequency Response of BJT Amplifier, Low Frequency Response of FET Amplifier, Miller Effect Capacitance, Multistage frequency effects

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **Self-study topics:** Depletion and Enhancement type MOSFET's, High frequency response of BJT/FET Amplifier **RBT Level:** L1, L2, L3

MODULE-4

Power Amplifiers:- Introduction: Definitions and Amplifier Types, Series Fed Class A Amplifier, Transformer Coupled Class A Amplifier, Class B Amplifier operation. Class B amplifier circuits:-Transformer-Coupled Push-Pull, Complementary–Symmetry, Amplifier Distortion **Feedback and Oscillator Circuits:-** Feedback concepts, Feedback connection types, effects of negative feedback, practical feedback circuits: -BJT based current series and voltage shunt feedback. Oscillator operation, Barkhaunsen's criteria, RC phase oscillator using BJT, Tuned oscillator Circuits: BJT based Hartley oscillator, Transistor Crystal oscillator	
Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **Self-study topics:** Determination of second harmonic distortion, voltage series feedback amplifier circuit, Colpitts oscillator using BJT/FET **RBT Level:** L1, L2, L3
MODULE-5	
Overview of Power Electronic Systems: Power Electronic Systems, Power semiconductor devices, Power Electronic Converters and Applications. **Thyristors:** Construction and operation of SCR, Static V-I characteristics, Two transistor model, Turn-ON methods, Turn OFF methods, Comparison between Transistors and Thyristors **Gate Trigger Circuit:** Resistance Firing Circuit, Resistance capacitance firing circuit, Unijunction Transistor: Basic operation and UJT Firing Circuit	
Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **Self-study topics:** Thyristor ratings, Pulse transformer triggering circuits, optical isolators, Block diagram of UPS **RBT Level:** L1, L2, L3

PRACTICAL COMPONENT

Sl.NO	Experiments
1	Determination of ripple factor and efficiency of full wave rectifier using center-tapped transformer
2	Determination of ripple factor and efficiency of full wave bridge rectifier
3	Static V-I characteristics of UJT
4	Static V-I characteristics of SCR
5	Design and testing of Common emitter BJT voltage divider biasing circuit
6	Frequency response of single stage BJT RC coupled amplifier
7	Drain characteristics and transfer characteristics of JFET
8	Testing of Complementary symmetry class B push-pull amplifier
9	Study of RC phase shift oscillator using BJT
10	Study of Common source JFET amplifier
11	Study of Crystal oscillator using BJT
12	Study of AC voltage controller using TRIAC and DIAC

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Design and implement a biasing circuit for BJT and FET
- Model the BJT/FET amplifier for ac analysis
- Analyze Frequency response of BJT and FET amplifier
- Acquire the knowledge of classifications of Power amplifier, operation, and design power amplifier
- Understand the feedback concepts and designing of oscillator circuits
- Understand the power electronic devices and basic power electronic circuits.

Assessment Details (both CIE and SEE)

The Weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

3. The question paper will have ten questions. Each question is set for 20 marks.
4. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
5. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources: Books

1.Electronic Devices and Circuit Theory-Robert L Boylestad, Louis Nashelsky, 10th edition, PEARSON

2.Power Electronics-M D Singh, K B Khanchandani, Second edition 2012, McGraw-Hill

Web links and Video Lectures (e-Resources):

- Integrated Electronics: Analog and Digital Circuits and Systems, Jacob Millman, Christos C. Halkias, McGraw-Hill, 2015.
- Electronic Devices and Circuits, David A Bell, 5th edition, OXFORD University press

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Quizzes
Surprise Tests
Assignments
Seminars

III Semester

DIGITAL DESIGN AND HDL			
Course Code (IPCC)	**21EI/BM33**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	4	Exam Hours	3

Course objectives:

- To impart the concepts of simplifying Boolean expression using K-map techniques and Quin- McCluskey minimization techniques.
- To impart the concepts of designing and analyzing combinational logic circuits.
- To impart design methods and analysis of sequential logic circuits.
- To impart the concepts of HDL-Verilog data flow and behavioral models for the design of digital systems.

Teaching-Learning Process (General Instructions)

The sample strategies, which the teacher can use to accelerate the attainment of the various courseoutcomes are listed in the following:

1. Lecture method (L) does not mean only the traditional lecture method, but a different type ofteaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various techniques.
3. Encourage collaborative (Group) Learning in the class
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes criticalthinking
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinkingskills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Topics will be introduced in multiple representations.
7. Show the different ways to solve the same problem and encourage the students to come up withtheir own creative ways to solve them.

Discuss how every concept can be applied to the real world - and when that's possible, it helpsimprove the students' understanding.

MODULE-1

Principles of Combinational Logic: Definition of combinational logic, Canonical forms, Generation of switching equations from truth tables, Karnaugh maps- up to 4 variables, Quine-McCluskey Minimization Technique.Quine-McCluskey using Don't Care Terms.
(Text 1).

Teaching-Learning Process	Chalk and talk method. RBT Level L2 L3 L4

MODULE-2

Logic Design with MSI Components and Programmable Logic Devices:
Binary Adders and Subtractors, Comparators, Encoders, Multiplexers, Programmable Logic Devices (PLDs), Programmable Read only Memories (PROMS). (Text 2)

Teaching-Learning Process	Chalk and talk method. Power point presentation RBT Level L1 L2 L3

MODULE-3

Flip-Flops:
Latches, Timing Considerations, The Master-Slave Flip-flops (Pulse-Triggered flip-flops): SR flip-flops, JK flip flops, Additional types of Master-Slave Flip-flops, Edge Triggered Flip-flops- The positive Edge triggered D Flip-flop, Characteristic equations. (Text 2)

Teaching-Learning Process	Chalk and talk method. Power point presentation RBT Level L1 L2 L3

MODULE-4

Simple Flip-Flops Applications: Registers, Binary Ripple Counters, Counters based on Shift Registers, Design of Synchronous Mod-N Counter using clocked T , JK , D and SR flip-flops. Self-correcting counters(Text 2).

Teaching-Learning Process	Chalk and talk method. Power point presentation RBT Level L2 L3 L4

MODULE 5

Introduction to Verilog:
Structure of Verilog module, Operators, Data Types, Styles of Description- Data flow description, Behavioral

description. Implementation of half adder and full adder using Verilog data flow description. **Verilog Behavioral description:** Structure, Sequential Statements, Case statement, Loop Statements, Verilog Behavioral Description of Multiplexers(2:1,4:1,8:1). (Text 3)	
Teaching-Learning Process	Chalk and talk method. Power point presentation RBT Level L3 L4 L5

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	Simplification, realization of Boolean expressions using logic gates/Universal Gates
2	To design and implement (a) Adder/Subtractor – Full/half using logic gates. (b) 4-bit Parallel Adder/ subtractor using IC 7483.
3	To realize (a)Binary to Gray code conversion and vice versa (b)Priority encoder and 3:8 Decoder using IC74138 (c)One / Two bit comparator
4	To realize the following flip-flops using NAND Gates T type (b) JK Master slave (c) D type
5	To design and implement the 3-bit Mod-N synchronous counters using 7476.
6	Adder/Subtractor – Full/half using Verilog data flow description
7	Flip-flops using Verilog Behavioral description (a) JK type b) SR type c) T type and d) D type
8	Counter Up/ Down (Binary), sequential counters using Verilog.
	Demonstration Experiments(for CIE) Use FPGA/CPLD kits for downloading verilog codes and check the output for interfacing experiments.
9	Verilog program to interface a stepper motor to rotate the motor in specified direction
10	Verilog program to interface a Relay
11	Verilog program to interface a Waveform generation using DAC
12	Verilog program to interface switches and LEDs

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Simplify Boolean functions using K-map and Quine-McCluskey minimization technique
- Analyze and design for combinational logic circuits.
- Analyze the concepts of Latches and Flip Flops. (SR, D, T and JK).
- Analyze and design the synchronous sequential circuits.
- Implement Combinational circuits(adders, subtractors, multiplexers) & sequential circuits using Verilog descriptions..

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester

- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

6. The question paper will have ten questions. Each question is set for 20 marks.
7. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
8. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Text Book:

1. Digita**l** Logic Applications and Design by John M Yarbrough, Thomson Learning,2001
2. Digital Principles and Design by Donald D. Givone, McGraw Hill, 2002.
3. HDL Programming VHDL and Verilog by Nazeih M. Botros, 2009 reprint, Dreamtech press.

Reference Books:

1. Fundamentals of logic design, by Charles H Roth Jr., Cengage Learning
2. Digital Principles and Design – Donald D Givone,12threprint, TMH,2008
3. Logic Design, Sudhakar Samuel, Pearson/ Saguine, 2007
4. Fundamentals of HDL- Cyril P R Pearson/Sanguin 2010

Web links and Video Lectures (e-Resources):

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Programming Assignments / Mini Projects can be given to improve programming skills

III Semester

INSTRUMENTATION, MEASUREMENTS AND BIOMEDICAL TRANSDUCERS			
Course Code (PCC)	**21BM34**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	3

Course objectives:

- Gain the knowledge of working principle and construction details of Biomedical Transducers.
- Acquire the knowledge of transducer applications to access the biological signals.
- Access the performance of various Biomedical Transducers.

Teaching-Learning Process (General Instructions)

These are sample strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, innovative teaching methods may be adopted so that the delivered lesson shall enable the students to attain the outcomes.
2. Show videos/animations to explain the fundamental concepts and working of instruments/ transducers.
3. Encourage collaborative (Group) learning in the class.
4. Ask higher order thinking questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce the topics in a manifold representation.
7. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
8. Discuss how concepts can be applied to the real world problem to enable the students to develop appropriate skills.
9. Adopt flipped class technique by sharing the materials / sample videos prior to the class and have discussions on the that topic in the succeeding classes.

Module-1

Fundamental Concepts & Basic Transducers: Introduction, Classification of Transducers, Measurement, Signals and Noise in the measurement-Measurement, signals and noise, signal to noise ratio, different types of noise. Characteristics of Measurement system-Transducer and measurement system, static characteristics, dynamic characteristics, standard and calibration, accuracy and error.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-2

Bioelectric Signals and Electrodes: Sources of Biomedical Signals, Origin of Bioelectric Signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes– Electrode-tissue interface, Electrolyte-Skin interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-3

Pressure Measurement: Pressure Transducers-LVDT pressure transducers and Strain gauge pressure transducers. Physiological pressure ranges and measurement sites, Direct pressure measurement-catheters for pressure measurement, diaphragm displacement transducers, catheter tip pressure transducers, implantable pressure transducers and pressure telemetering capsules. Indirect pressure measurement-Indirect measurement of systolic, diastolic, and mean blood pressure, Detection of Kortokoff sounds.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-4

Temperature Measurement, Transducers and Sensors: Requirements for measurement ranges, Temperature transducers – Thermistors, thermocouples, wire and thin film thermo-resistive elements, P-N junction diodes and transistors, infrared radiation thermometers, infrared thermography. Clinical thermometer probes, tympanic thermometers, telemetering capsules. Photoelectric Transducers: photovoltaic cells and photoemissive cells. Biosensors and Smart Sensors.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-5

Flow Measurement: Requirements for measurement ranges – blood flow in a single vessel, tissue blood flow, and respiratory gas flow. Electromagnetic flowmeters – principle, methods of magnetic field excitation, perivascular probes, intravascular probes. Ultrasonic blood flowmeters– propagation of ultrasound in the tissue, ultrasonic

Doppler flowmeters, blood flow measurement through Doppler imaging. Indicator dilution method – principle and working, thermodilution method, Fick method, thermistor velocity probe, impedance cardiography

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Course outcome (Course Skill Set): At the end of the course the student will be able to :

1. Define and explain the concepts of measurement, instrument, transducer, static & dynamic characteristics.
2. Describe the origin and nature of biopotentials, and the electrodes used for the measurement of biosignals.
3. Discuss the principle, construction and working of transducers for the measurement of pressure.
4. Explain the principle, construction and working of transducers for the measurement of temperature.
5. Discuss the principle, construction and working of transducers for the measurement of flow.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

7. First test at the end of 5th week of the semester
8. Second test at the end of the 10th week of the semester
9. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

10. First assignment at the end of 4th week of the semester
11. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

12. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

9. The question paper will have ten questions. Each question is set for 20 marks.
10. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
11. The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Biomedical Transducers and Instruments – Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.
2. Handbook of Biomedical Instrumentation- R S Khandpur, 2nd edition, Tata McGraw Hill, 2003.

Reference Books:

1. Biomedical Instrumentation and Measurement – Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India Pvt. Ltd., 2004.
2. Transducers and Instrumentation -D. V. S. Murty Prentice Hall India Pvt ltd. 2nd Edition

Web links and Video Lectures (e-Resources):

- **https://www.youtube.com/watch?v=mj0b__ManRA**
- **https://www.youtube.com/watch?v=iK-6q4nnmtA**
- **https://www.youtube.com/watch?v=OqNDFF1RsMU**
- **https://www.youtube.com/watch?v=UTudEz0U_fo**
- **https://www.youtube.com/watch?v=49CWbXNJ3WE**

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Explore the use of different type of transducers and sensors for the measurement of biomedical signals.
- Demonstration of biomedical instruments and transducers in the laboratory.
- Visit to hospitals to learn the real time acquisition of biomedical signals using different types of transducers and electrodes.

III Semester

MEASUREMENT AND BIOMEDICAL TRANSDUCERS LAB			
Course Code (PCC Lab)	21BML35	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03

Course objectives:

. This Lab course will enable the students to

- Impart the working principle of sensors and transducer
- Testing the response and plot the characteristics of different transducers
- Interpret and analyze experimental results with theoretical concepts.
- Calibrate the sensors/transducers
- Study and interpret data sheets of different transducers to select the suitable transducer for particularapplication and safe operation.
- Understand the basic concepts and procedure for the measurement of BP, solution concentration, pH andconductivity.

Sl.NO	Experiments
1	Measurement of displacement using LVDT & determine its sensitivity and resolution.
2	Temperature measurement using RTD, Thermistor and Thermocouple, and to find their sensitivity.
3	Temperature measurement using AD590 / LM34.
4	Characteristics of LDR, Photodiode & Phototransistor by variable illumination & variable distance.
5	Measurement of unknown resistance by Wheatstone bridge & finding the sensitivity of the bridge.
6	Measurement of self-inductance using Maxwell's bridge.
7	Measurement of inductance and internal resistance of a choke by three voltmeter method.
8	Measurement of unknown capacitance using Schering's bridge.
9	Characteristics of Load cell and Cantilever beam using Strain gauge (Quarter, Half and Full bridge
10	Measurement of blood pressure using sphygmomanometer and automatic digital BP instrument. Finding the systolic and diastolic values and calculate Mean Arterial Pressure (MAP).
11	Measurement of unknown concentration of given solution/body fluid using Spectrophotometer and Colorimeter
12	Measurement of pH of a given solution/ body fluid using pH meter. (b) Determination of Conductivity of a given unknown solution/ body fluid using conductivity meter

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Analyze the response and plot the characteristics of temperature measurement transducers such as RTD,Thermistor, and Thermocouple & AD590.
- Analyze the response and plot the characteristics of displacement measuring transducers such as LVDT and Potentiometric transducer.
- Analyze the response and plot the characteristics of strain gauge type load cell.
- Analyze the response and plot the characteristics of pressure transducer.
- Measure unknown values of resistance, capacitance and Inductance using different bridges.
- Design , build and test the circuits for practical applications using transducers
- Measure BP, solution concentration, pH and conductivity for different biomedical applications..

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).
- The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course is 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.
- The duration of SEE is 03 hours
- Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Biomedical Transducers and Instruments – Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.
2. Handbook of Biomedical Instrumentation- R S Khandpur, 2nd edition, Tata McGraw Hill, 2003.
3. Biomedical Instrumentation and Measurement – Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India Pvt. Ltd., 2004.
4. Transducers and Instrumentation -D. V. S. Murty Prentice Hall India Pvt ltd. 2nd Edition.
5. Electronic Instrumentation - H. S. Kalsi, TMH, 3rd Edition, 2012

III Semester

HUMAN ANATOMY AND PHYSIOLOGY			
Course Code	21BM381	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- To understand the internal environment of human body and homeostasis mechanism
- To provide the basic knowledge of different types of tissues.
- To provide the knowledge of structure and functioning of nervous system, cardiovascular system, respiratory system, digestive system and musculoskeletal system
- To provide the knowledge of physiological parameters of normal health and factors affecting variousphysiological processes in the body

Teaching-Learning Process (General Instructions)

These are sample strategies, which teacher can use to accelerate the attainment of the various course outcomes.

10. In addition to the traditional lecture method, innovative teaching methods may be adopted so that the delivered lesson shall enable the students to attain the outcomes.
11. Show videos/animations to explain the fundamental concepts and working of instruments/ transducers.
12. Encourage collaborative (Group) learning in the class.
13. Ask higher order thinking questions in the class, which promotes critical thinking.
14. Adopt Problem Based Learning (PBL), which fosters students' analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
15. Introduce the topics in a manifold representation.
16. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
17. Discuss how concepts can be applied to the real world problem to enable the students to develop appropriate skills.
18. Adopt flipped class technique by sharing the materials / sample videos prior to the class and have discussions on the that topic in the succeeding classes.

Module-1

Introduction: Homeostasis, Tissue, Cartilage: The internal environment and homeostasis, survival needs of the body, movement of substances within the body, body fluids, action potential, propagation of action potential, cell-structure and functions. Epithelial tissue- simple epithelium, stratified epithelium, connective tissue- cells of connective tissue, loose connective tissue, Adipose tissue, Dense connective tissue, Lymphoid tissue, Cartilage- Hyaline cartilage, Fibrocartilage, Elastic cartilage.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-2

Nervous System: Functional Components of nervous system**,** Neurons: Properties of neurons, Cell bodies, Axon and Dendrites, Types of nerves, Synapse and neurotransmitters, neuromuscular junction. Central nervous system: Meninges, ventricles of the brain and CSF. Brain: Cerebrum, functions of cerebrum, functional areas of the cerebrum, Brainstem, Cerebellum, Spinal cord- grey matter, white matter, spinal reflex, Spinal nerves (in brief list& functions), Cranial nerves (in brief list & functions), Autonomic nervous system (in brief)- functions and effects. Pituitary gland and hypothalamus.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-3

Cardiovascular System: Introduction, Blood vessels- Arteries and Arterioles, Veins and Venules, capillaries, control of blood vessel diameter, blood supply- internal respiration, cell nutrition. Heart- position, structure-pericardium, myocardium, endocardium, interior of the heart, flow of blood through the heart, blood supply to heart, Conducting system of the heart, factors affecting heart rate, the Cardiac cycle, cardiac output, blood pressure, control of blood pressure, pulse and factors affecting the pulse rate. Circulation of the blood- pulmonary circulation, systemic circulation-aorta (different parts of aorta & their blood supply, in brief). Summary of the main blood vessels (arteries & veins, explanation with flow diagram only)

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-4

Respiratory System: Organs of respiration, Nose and Nasal cavity- position, structure and functions, pharynx - position, structure, functions. Larynx - position, structure and functions. Trachea, bronchi, bronchioles and alveoli, lungs- position, associated structure, pleura and pleural cavity. Respiration - muscles of respiration, cycle of respiration, variables affecting respiration, lung volumes and capacity

Digestive System: Organs of the digestive system – mouth, tongue, teeth, salivary glands, pharynx, oesophagus, stomach, gastric juice and functions of stomach, small intestine-structure, chemical digestion in small intestine, large intestine - structure, functions of the large intestine. Pancreas and Liver (only physiology)

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-5

Skeletal System: Bone, Types of bone, structure, bone cells, functions of bone. Axial skeleton- skull, sinuses, Fontanelles, vertebral column characteristics of typical vertebra, different parts of vertebral column (parts only), features of vertebral column, movements and functions of vertebral column, sternum, ribs, shoulder girdle and upper limb, pelvic girdle and lower limb.

Muscles and Joints (Study of muscles along with joints): Muscle tissue: Skeletal muscle, Smooth muscle, Cardiac muscle, functions of muscle tissue, muscle tone and fatigue. Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbow joint, radioulnar joint, wrist joint, Hip joint, Knee joint, ankle joint.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Course outcome (Course Skill Set): At the end of the course the student will be able to :

- Describe internal environment of human body and explain the fundamental concept of homeostasis.
- Explain the structure and functioning of various types of tissues.
- Describe the structure and explain the functioning of various nervous system, cardiovascular system, respiratory system, digestive system and musculoskeletal system.
- Demonstrate and analyze various physiological parameters in normal and abnormal conditions.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

1. First assignment at the end of 4th week of the semester
2. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Text Books:

1. Ross & Wilson's Anatomy and Physiology in Health and Illness – by Anne Waugh and Allison Grant, 9th Edition, Churchill Livingstone Publications

Reference Books:

1. Concise Medical Physiology- by Sujit K. Chaudhuri, 5th Edition, New Central Book Agency Pvt. Ltd.
2. Essentials of Medical Physiology - by K. Sembulingam and PremaSembulingam, 3rd Edition, Jaypee Publications
3. Human Physiology: From Cells to Systems – by Lauralee Sherwood, 6th Edition, Thomson India Edition, 2007.

Web links and Video Lectures (e-Resources):

• https://nptel.ac.in/courses/102104058 • https://www.youtube.com/watch?v=Evsqy0a_Lrk • https://www.youtube.com/watch?v=BxmBfTZiUW8
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • **Visit to anatomy and physiology departments in the medical colleges and hospitals**

III Semester

NETWORK ANALYSIS			
Course Code (AEC Theory)	**21EI/BM382**	CIE Marks	50
Teaching Hours/Week (L: T: P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hours	Total Marks	100
Credits	01	Exam Hours	01

Course objectives: This course will enable students to:

1. Apply mesh and nodal techniques to solve an electrical network.
2. Solve different problems related to Electrical circuits using Network Theorems and Two portnetwork.
3. Familiarize with the use of Laplace transforms to solve network problems.
4. Be familiar with the most fundamental Graph theory topics and results.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
- Show Video/animation films to explain functioning of various concepts.
- Encourage collaborative (Group) Learning in the class .
- Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking.
- Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
- Topics will be introduced in a multiple representation.
- Show the different ways to solve the same problem and encourage the students to come up withtheir own creative ways to solve them.
- Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
- Adopt Flipped class technique by sharing the materials / Sample Videos prior to the class and have discussions on the that topic in the succeeding classes.
- Give Programming Assignments.

Module-1

Basic concepts
Types of Sources, Loop analysis, Nodal analysis with independent DC and AC Excitations.(Textbook 1: 2.3, 4.1, 4.2, 4.3, 4.4, 10.6)

Teaching- Learning Process	Chalk and Talk, YouTube videos. **RBT Level:** L1, L2, L3

Module-2

Network theorems: Super position theorem, Thevenin's theorem, Norton's Theorem (for DC networks only), Maximum power transfer theorem (for AC & DC networks).(Textbook 2: 9.2, 9.4, 9.5, 9.7)

Teaching- Learning Process	Chalk and Talk, Demonstrate the concepts using circuits **RBT Level:** L1, L2, L3

Module-3

Laplace transform and its Applications: Step Ramp, Impulse, Solution of networks using Laplace transform, Initial value and final value theorem (Textbook 3: 7.1, 7.2, 7.4, 7.7, 8.4)

Teaching-Learning Process	Chalk and Talk, YouTube videos. **RBT Level:** L1, L2, L3

Module-4

Two port networks: Short- circuit Admittance parameters, Open- circuit Impedance parameters (Textbook 3: 11.1, 11.2, 11.3)	
Teaching-Learning Process	Chalk and Talk, YouTube videos. **RBT Level:** L1, L2, L3
Module-5	
Graph theory: Graph of a network, concepts of: tree & co-tree, incidence matrix, tie-set & cut-set schedules.(Text book 2:8.2,8.3,8.4,8.5,8.6)	
Teaching-Learning Process	Chalk and Talk, YouTube videos. **RBT Level:** L1, L2, L3

Course Outcomes

At the end of the course the student will be able to:

1. Analyse and solve Electric circuit, by applying loop analysis, Nodal analysis and by applying network Theorems
2. Apply Laplace transforms to solve electric networks
3. Apply Two-port network formulation for analyzing electric circuits
4. Apply graph theoretic formulation for the solutions of network equations.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

1. First test at the end of 5^{th} week of the semester
2. Second test at the end of the 10^{th} week of the semester
3. Third test at the end of the 15^{th} week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4^{th} week of the semester
5. Second assignment at the end of 9^{th} week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20Marks** (**duration 01 hours**)

6. At the end of the 13^{th} week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marksand will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of themethods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common questionpapers for the subject (**duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with amaximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Text Books

1. Engineering circuit analysis, William H Hayt, Jr, Jack E Kemmerly, Steven M Durbin, Mc Graw HillEducation, Indian Edition 8e.
2. Networks and Systems, D Roy Choudhury, New age international Publishers, second edition.
3. Network Analysis, M E Van Valkenburg, Pearson, 3e.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/108106098
- https://nptel.ac.in/courses/108102042

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Programming Assignments / Mini Projects can be given to improve programming skills

III Semester

DIGITAL DESIGN LAB USING PSPICE/MULTISIM			
Course Code (AEC Lab)	**21EI/BM383**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	1	Exam Hours	02

Course objectives:

This course will enable the students

To provide hands-on experience in designing and implementing digital circuits. The experiments are designed to give students ability to design, build and implement digital circuits & systems. The Pspice /Multisim simulator helps to evaluate the design of combinational and sequential circuits.

Sl.NO	Experiments
1	Implementation of De Morgan's theorem and SOP/POS expressions using Pspice/Multisim.
2	Implementation of Half Adder, Full Adder, Half Subtractor and Full Subtractor using Pspice/Multisim.
3	Design and implementation of 4-bit Parallel Adder/ Subtractor using IC 7483 using Pspice/Multisim.
4	To realize Binary to Gray code conversion and vice versa using Pspice/Multisim.
5	To realize BCD to excess 3 and vice versa using Pspice/Multisim.
6	To realize Priority encoder and 3:8 Decoder using Pspice/Multisim.
7	To realize One / Two bit comparator using Pspice/Multisim.
8	To realize 4:1 Multiplexer using gates with Pspice/Multisim.
9	To realize 1:8 Demux with Pspice/Multisim.
10	To realize the following flip-flops using NAND Gates (a)T type (b) JK Master slave (c) D type using Pspice/Multisim.
11	To design and implement the 3-bit Mod-N synchronous counters using Pspice/Multisim.
12	To design and implement the Binary ripple counters (up/down) using Pspice/Multisim.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. Demonstrate the truth table of various expressions and combinational circuits using logic gates.
2. Design various combinational circuits such as adders, subtractors, comparators, multiplexers and code converters.
3. Construct flips-flops and counters.
4. Design and implement synchronous counters..

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1. Digital Logic Applications and Design by John M Yarbrough, Thomson Learning, 2001
2. Digital Principles and Design by Donald D Givone, McGraw Hill, 2002.

III Semester

AEC LAB USING PSPICE/MULTISIM			
Course Code (AEC Lab)	21EI/BM384	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course objectives:

- To provide practical exposure to the students on designing, setting up, executing and debuggingvarious electronic circuits using simulation software.
- To give the knowledge and practical exposure on simple applications of analog electronic circuits.

Sl.No	Experiments using Pspice/MultiSIM software
1	Experiments to realize diode clipping (single, double ended) circuits.
2	Experiments to realize diode clamping (positive, negative) circuits.
3	Experiments to realize Full wave rectifier without filter (and set-up to measure the ripple factor, Vp-p, Vrms, etc.).
4	Design and conduct an experiment on Series Voltage Regulator using Zener diode to determineline/load regulation characteristics.
5	Realize BJT Darlington Emitter follower without bootstrapping and determine the gain, input andoutput impedances (other configurations of emitter follower can also be considered).
6	Experiment to realize Input and Output characteristics of BJT Common emitter configuration and evaluation of parameters.
7	Experiments to realize Transfer and drain characteristics of a MOSFET.
8	Set-up and study the working of class A power amplifier and calculate the efficiency
9	Set up and study the response of a two stage RC-coupled amplifier and calculate gain and bandwidth
10	To design and test the Common emitter-Common base cascade amplifier to determine the gain and bandwidth from its frequency response.
11	Design and set-up the Wein bridge oscillator and determine the frequency of oscillation
12	Design and set-up the oscillator circuits (Hartley/ Colpitts using BJT/FET) and determine thefrequency of oscillation

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. Understand the circuit schematic and its working.
2. Study the characteristics of different electronic devices.
3. Design and test simple electronic circuits as per the specifications using discrete electronic components.
4. Compute the parameters from the characteristics of active devices.
5. Familiarize with EDA software which can be used for electronic circuit simulation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} weekof the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners).

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours.

Rubrics suggested in Annexure-II of Regulation book.

Suggested Learning Resources:

1. David A Bell, "Fundamentals of Electronic Devices and Circuits Lab Manual, 5th Edition, 2009, Oxford University Press.
2. Muhammed H Rashid, "Introduction to Pspice using Or CAD for circuits and electronics", 3^{rd} Edition, Prentice Hall, 2003.

Biomedical Engineering (BM)

IV Semester

B.E MATHS SYLLABUS (for BT, CH, CV, ECE, EEE, EIE, NANO)
Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)
(Effective from the academic year 2022-2023)
SEMESTER – IV

COMPLEX ANALYSIS, PROBABILITY AND STATISTICAL METHODS

Course Code	21MAT41	CIE Marks	50
Teaching Hours/Week (L: T:P)	2:2:0	SEE Marks	50
Total Number of Contact Hours	40	Total Marks	100
Credits	03	Exam Hours	3

Course Objectives: This course(21MAT41) will enable students to:

1. Provide insight into applications of complex variables, conformal mapping arising in potential theory, quantum mechanics, heat conduction and field theory.
2. Special functions familiarize the Power series solution required to analyse the Engineering Problems.
3. To have insight into Statistical methods, Correlation and regression analysis.
4. To develop probability distribution of discrete and continuous random variables, Joint probability distribution occurs in digital signal processing, design engineering and microwave engineering.

Teaching-Learning Process (General Instructions):

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

7. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
8. State the need for Mathematics with Engineering Studies and Provide real-life examples.
9. Support and guide the students for self–study.
10. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
11. Encourage the students for group learning to improve their creative and analytical skills.
12. Show short related video lectures in the following ways:
    - As an introduction to new topics (pre-lecture activity).
    - As a revision of topics (post-lecture activity).
    - As additional examples (post-lecture activity).
    - As an additional material of challenging topics (pre-and post-lecture activity).
    - As a model solution for some exercises (post-lecture activity).

Module – 1

Complex Analysis: Review of a function of a complex variable, limits, continuity and differentiability. Analytic functions: Cauchy-Riemann equations in cartesian and polar forms and consequences. Construction of analytic functions by Milne-Thomson method, Problems.

Complex integration: Line integral of a complex function, Cauchy's theorem and Cauchy's integral formula and problems. **(8 Hours)**

Self-Study: Conformal transformations: Discussion of transformations: $w = z^2$, $w = e^z$, $w = z + 1/z$ ($z \neq 0$). Bilinear transformations- Problems.

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 2

Special functions: Series solution of Bessel's differential equation leading to $J_n(x)$ Bessel's function of the first kind, Properties, Orthogonality of Bessel's functions. Series solution of Legendre's differential

equation leading to $P_n(x)$-Legendre polynomials. Rodrigue's formula (without proof), problems. **(8 Hours)**

Self Study: Recurrence Relations.

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 3

Statistical Methods: Correlation and regression-Karl Pearson's coefficient of correlation and rank correlation, problems. Regression analysis, lines of regression, problems.

Curve Fitting: Curve fitting by the method of least squares, fitting the curves of the forms $y = ax + b$, $y = ax^b$ *and* $y = ax^2 + bx + c$. **(8 Hours)**

Self-study: Angle between two regression lines, problems.

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 4

Probability Distributions: Review of basic probability theory. Random variables (discrete and continuous), probability mass and density functions. Mathematical expectation, mean and variance. Binomial, Poisson and normal distributions- problems (derivations for mean and standard deviation for Binomial and Poisson distributions only)-Illustrative examples. **(8 Hours)**

Self-study: Exponential distribution.

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Module – 5

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance and correlation.

Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student's t-distribution, Chi-square distribution as a test of goodness of fit. **(8 Hours)**

Self-Study: Point estimation and interval estimation.

(RBT Levels: L1, L2 and L3)

Pedagogy	Chalk and Board, Problem based learning

Course Outcomes

Course Outcomes: At the end of the courses, the students will be able to:

1. Use the concepts of an analytic function and complex potentials to solve the problems arising in electromagnetic field theory. Utilize conformal transformation and complex integral arising in aerofoil theory, fluid flow visualization and image processing.
2. Obtain Series Solutions of Ordinary Differential Equation.
3. Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.
4. Apply discrete and continuous probability distributions in analysing the probability models arising in the engineering field.
5. Construct joint probability distributions and demonstrate the validity of testing the hypothesis.

ASSESSMENT PATTERN (BOTH CIE AND SIE)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

3. First test at the end of 5th week of the semester
4. Second test at the end of the 10th week of the semester
5. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

6. First assignment at the end of 4th week of the semester
7. Second assignment at the end of 9th week of the semester

   Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
8. At the end of the 13th week of the semester

   The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

   (to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

   CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

   Semester End Examination:

   Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

   The students have to answer 5 full questions, selecting one full question from each module

Textbooks:

1. Higher Engineering Mathematics, B. S. Grewal Khanna Publishers 44th Edition, 2017.
2. Advanced Engineering Mathematics, E. Kreyszig: John Wiley & Sons, 10th Ed. (Reprint), 2016.

References:

1. Advanced Engineering Mathematics C. Ray Wylie, Louis C.Barrett McGraw-Hill 6th Edition 1995.
2. Higher Engineering Mathematics B. V. Ramana McGraw-Hill 11th Edition,2010.
3. A Text-Book of Engineering Mathematics N. P. Bali and Manish Goyal Laxmi Publications 2014.
4. Advanced Engineering Mathematics Chandrika Prasad and Reena Garg Khanna Publishing, 2018.

Web links and Video Lectures (e-Resources):

http://nptel.ac.in/courses.php?disciplineID=111
http://www.class-central.com/subject/math(MOOCs)
http://academicearth.org/
http://www.bookstreet.in.
VTU EDUSAT PROGRAMME – 20
VTU e-Shikshana Program

Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes
- Assignments
- Seminars

IV Semester

EMBEDDED CONTROLLERS			
Course Code (IPCC)	**21EI/BM42**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

This course will enable students to:

- Understand the difference between a Microprocessor and a Microcontroller and embedded microcontrollers and different architectures. Familiarize the basic architecture of 8051 microcontroller.
- Learn instructions and Program 8051microcontroller using Assembly Level Language, addressing modes, directives.
- Learn basics of C for 8051 and C program for 8051

. Understand the operation and use of inbuilt Timers/Counters and Serial port of 8051

- Interface 8051 to external memory and I/O devices using its I/O ports. Understand the interrupt system of 8051 and the use of interrupts

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. . Lecture method (L) does not mean only the traditional lecture method, but a different type of teaching method may be adopted to develop the outcomes.
2. Show Video/animation films to explain the functioning of various techniques.
3. Encourage collaborative (Group) Learning in the class
4. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
7. Discuss how every concept can be applied to the real world - and when that's possible, it helps to improve the students' understanding.
8. Give Programming Assignments.

MODULE-1

Introduction: Microprocessor and Microcontroller, Microprocessor survey, RISC and CISC CPU Architecture. Harvard and Von-Neumann CPU Architecture. 8051 Microcontroller Architecture. Pin functions description. Input/ Output port pins and circuits. Internal and External memory Architecture. 8051 Reg. banks and stack. 8051 flag bits and PSW Register. Special function Registers. Timer /Counter, Serial data input/ output. Interrupts. program counter and ROM space in the 8051.

Teaching-Learning Process	Chalk and talk method/power point presentation **(RBT levels L1,L2,)**

MODULE-2

Addressing modes directives instruction set of 8051 Microcontroller. Immediate and Register addressing modes. Accessing memory using various addressing modes. Bit addressing for I/O and RAM. 8051 data types and directives. Jump Loop and CALL Instructions Arithmetic and Logic Instructions and programming. I/O port programming. Assembly Language program instructions
various

Teaching-Learning Process	Chalk and talk method/power point presentation **(RBT levels L1,L2,)**

MODULE-3

8051 programming in C. Advantages of programming 8051 in C. Data types and time delay in 8051 C. I/o programming. Bit addressable programming. Logic operations. data conversion programs. Accessing Code ROM Space, data serialization using 8051 C.	
Teaching-Learning Process	Chalk and talk method/power point presentation **(RBT levels L1,L2,)**
MODULE-4	
Timer/ Counter, Serial communication in 8051. Programming 8051 timer/ counter, programming timer 0 and 1 in 8051 C. Basics of serial communication. 8051 connections to RS-232. 8051 serial port programming in assembly and C.	
Teaching-Learning Process	Chalk and talk method/power point presentation **(RBT levels L1,L2,)**
MODULE 5	
Interfacing 8051: Interfacing of 8051 with ADC-0804, DAC, LCD , Stepper motor and keyboard and their 8051 Assembly and C language interfacing programming. **Interrupts:** Programming Timer Interrupts, External hardware Interrupts and serial communication Interrupts. Interrupts priority & Interrupt programming in C.	
Teaching-Learning Process	Chalk and talk method/power point presentation **(RBT levels L1,L2,L3)**

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Program for 8 bit and 16 bit addition. square root of 8 bit and 16 bit for 8051 microcontroller
2	Program using 8051 in Block, Move, Exchange.
3	Program in sorting, finding largest and smallest element in an array
4	Counters - For Hex and BCD up/ down count.
5	Boolean and Logical Instructions. (Bit Manipulation).
6	Code Conversions ---> ASCII to Decimal, Decimal to ASCII, BCD to ASCII
7	Subroutines using CALL and RETURN instructions
8	Programs to generate delay, programs using serial port and on chip timer/ counter.
9	Stepper motor Interface to 8051 Microcontroller with C Program
10	DC Motor Interface to 8051 Microcontroller with C Program
11	DAC Interface for to generate sine wave, square wave, triangular wave, Ramp wave through 8051Microcontroller with C Program.
12	Keyboard Interfacing

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

6. . At the end of the course the student will be able to:
7. Explain the difference between Microprocessors & Microcontrollers, Architecture of 8051 Microcontroller, Interfacing of 8051 to external memory and Instruction set of 8051.
8. Develop 8051 Assembly level programs using 8051 instruction set.
9. Develop 8051 Assembly / C language program to generate timings and waveforms using 8051 timers, to send & receive serial data using 8051 serial port.
10. Develop 8051 Assembly / C language programs to generate square wave on 8051 I/O port pin using interrupt and C Program to send & receive serial data using 8051 serial port.
    Interface various peripheral devices to 8051 using I/O ports.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

14. The question paper will have ten questions. Each question is set for 20 marks.
15. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
16. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1The 8051 Microcontroller and Embedded systems-using assembly and C", Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinaly,PHI,2006/pearson,2006

2The 8051 Microcontroller architecture. Programming and applications", Kenneth J Alyala Thomson learning 2005

Web links and Video Lectures (e-Resources):

1 VTU e-shikshana programmes

2 VTU Edu-sat programmes

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes
- Assignments
- Seminars

IV Semester

JAVA PROGRAMMING			
Course Code (IPCC)	**21EI/BM43**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

- To Understand object oriented programming concepts, and apply them in solving problems.
- To Understand Set up Java JDK environment to create, debug and run simple Java programs.
- To Understand Introduce the concepts of exception handling and multithreading.
- To Understand Introduce the design of Graphical User Interface using applets and swing controls.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop student's theoretical and programming skills.
2. State the need for learning Programming with real-life examples.
3. Support and guide the students for self–study.
4. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students' progress.
5. Encourage the students for group learning to improve their creative and analytical skills.
6. Show short related video lectures in the following ways:

- As an introduction to new topics (pre-lecture activity).
- As a revision of topics (post-lecture activity).
- As additional examples (post-lecture activity).
- As an additional material of challenging topics (pre-and post-lecture activity).
- As a model solution of some exercises (post-lecture activity).

MODULE-1 - 8 HOURS

Object Oriented Programming and JAVA: Object Oriented Paradigm, basic concepts, benefits and applications of OOPs. JAVA history and features, How java differs from C and C++, JAVA and Internet, JAVA and World Wide Web, Web browsers, JAVA support systems, JAVA environment. JAVA program structure, Tokens, Statements, JAVA Virtual Machine.

Overview of JAVA Language: Simple Java Program, Math functions, An application with two classes, Java program structure, Java Tokens, Java Statement, Implementing a Java Program, Java Virtual Machines, Command and Line Arguments, Programming Style.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

MODULE-2 - 8 HOURS

Constants, Variables, Data Types: Declaration and scope of Variables, Symbolic constants, Type Casting, Standard Default values.

Operators and Expression: Arithmetic, Relational, Logical, Assignment, Increment, Decrement, Conditional, Bitwise, Special Operators, Arithmetic Expressions, Evaluation, Procedure of Operators, Type Conversion in Expressions, Mathematical functions.

Decision Making, Branching and Looping: If Statement, If….Else statement, Nesting of statements, Switch Statement, Operator, While Statement, Do statement, For statement, Jump in Loops.

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

MODULE-3 - 8 HOURS

Classes, Objects and Methods: Class definition and declaration, Creating Object, Accessing Class Members, Constructors, Methods Overloading, Static Members, Nesting Methods, Inheritance, Overriding Methods, Final Variables and Methods, Final Classes, Finalizer Methods, Abstract Methods and Classes, Visibility Control.

Arrays, Strings and Vectors: One and two dimensional arrays, Strings, Vectors, Wrapper Classes

Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

MODULE-48 HOURS	
Interfaces: Definition, Extending and Implementing Interfaces, Accessing Interface variables. **Packages:** JAVA API Packages, Using System packages, Naming conventions, Creating, Accessing and Using a package, Adding a class to a Package, Hiding Classes. **Multithreaded Programming :** Creating and Extending Thread Class, Stopping, Blocking and Life Cycle of Thread, Using Thread Methods, Thread Exceptions and Priority, Synchronization, Implementing runnable Interface.	
Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

MODULE 5 - 8 HOURS	
Applet Programming: Introduction, How Applets Differ from Applications, Preparing to write Applets, Building Applet Code, Applet Life Cycle, Creating an Executable Applet , Designing a Web Page, Applet Tag, Adding Applet to HTML File, Running the Applet, Passing Parameters to Applets, Aligning the Display, More about HTML Tags, Displaying Numerical Values, Getting Input from the User, Event Handling.	
Teaching-Learning Process	Chalk and Talk, PowerPoint Presentation RBT Level: L1, L2, L3

PRACTICAL COMPONENT OF IPCC*(May cover all / major modules)*

Sl.NO	Experiments
1	a. Write a java Program to illustrate the creation of variables of basic types and effect of type conversions. b. Write a java Program that display the roots of a quadratic equation ax2+bx=0. Calculate the discriminate D and based on value of D, describe the nature of root.
2	a. Write a java program to demonstrate creation and accessing of objects and methods. b. Write a java program to illustrate use of constructor overloading and method overloading.
3	a. Write a java Program to demonstrate the concept of single Inheritance. b. Write a java program to implement multi level Inheritance.
4	Write a simple Program on Java to illustrate the implementation of the concept of multiple inheritance using interfaces.
5	a. Write a java program to demonstrate String Methods used for manipulating strings like accessing, inserting, modifying and appending. b. Write a java program to illustrate use of most commonly used wrapper class methods.
6	Write a Java program to implement the concept of importing classes from user defined package and creating packages.
7	Write a Java program using Synchronized Threads, which demonstrates Producer Consumer concept.
8	a. Write a Java program for creation of Java Built-in Exceptions. b. Write a Java program for creation of User Defined Exceptions.
9	Complete the following: i. Create a package named shape. ii. Create some classes in the package representing some common shapes like Square, Triangle, and Circle. **iii.** Import and compile these classes in other program
10	a. Write a Java program to copy bytes from one file to another using File Input Stream and File Output Stream. b. Write a Java program to illustrate the process of file concatenation and buffering.
11	Write a Java applet program, which handles keyboard event.
12	Write an Applet that displays ―Hello World‖ (Background color-black, text color-blue and your name in the status window.)
13	Write a Java Program to demonstrate Mouse events.
14	Write programs for using Graphics class i. To display basic shapes and fill them **ii.** Draw different items using basic shapes set background and foreground colors.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. To Understand OOPs concepts and basics of Java programming.
2. To Create Java programs using inheritance and polymorphism.
3. To Implement error-handling techniques using exception handling and multithreading.
4. To Develop GUI using Applets and Swing components.
5. Analyze, design and develop solutions to real-world problems applying OOPs concepts through JAVA.

Assessment Details (both CIE and SEE)

The Weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour**)

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks**.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

17. The question paper will have ten questions. Each question is set for 20 marks.
18. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
19. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the

SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources: Books.

1. E.Balaguruswamy – Programming with JAVA – A Primer – 5th Edition, McGraw Hill
2. Herbert Schildt, Java the Complete Reference, 7th Edition, Tata McGraw Hill, 2007.
3. Object oriented programming in TURBO C++ - Robert Lafore, Galgotia Publications, 2002.
4. Mahesh Bhave and Sunil Patekar, "Programming with Java", First Edition, PearsonEducation, 2008.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program
- https://www.w3schools.com/java/
- https://www.youtube.com/watch?v=CFD9EFcNZTQ
- https://www.youtube.com/watch?v=grEKMHGYyns

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes
- Assignments
- Seminars

IV Semester

SIGNAL CONDITIONING AND DATA ACQUISITION CIRCUITS			
Course Code (PCC)	**21EI/BM44**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives: This course will enable the students to

- Define and describe Op Amp, basic concepts, characteristics and specifications
- Gain knowledge about Linear and nonlinear applications of Op-amp.
- Design and develop circuits like, amplifiers, filters, Timers to meet industrial requirements.
- Get a firm grasp of basic principles of op-amp.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1.Lecture method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2.Show Video/animation films to explain evolution of communication technologies.
3. Encourage collaborative (Group) Learning in the class
4.Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
5.Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
6.Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
7.Discuss how every concept can be applied to the real world - and when that's possible, it helps to improve the students' understanding.

Module-1

Module -1

Introduction to Operational Amplifiers: Introduction, Block schematic of an Op-amp, Power supply connections, Characteristics of an Ideal OP-AMP, Inverting Amplifier, Non-inverting Amplifier, Voltage follower, Differential Amplifier, CMRR. (Relevant problems).

Operational Amplifier Characteristics: DC characteristics – Input bias current, Input offset current, Input offset voltage, Total output offset voltage, Thermal drift. AC characteristics – Frequency response, Slew rate, PSRR.

Basic Op-amp applications: Scale changer/Inverter,Summing amplifier: Inverting summing amplifier, Non-inverting Summing amplifier, Subtractor, Instrumentation Amplifier. (Relevant problems).

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **RBT Level:** L1, L2, L3

Module-2

Operational Amplifier Applications: V – I and I – V converter, Op-amp circuit using diodes, sample and hold circuit, Differentiator and Integrator.

Comparator and waveforms generator: Comparator, Regenerative comparator (Schmitt Trigger), Astable mutivibrator, Monostable multivibrator and Triangular waveform generator. Phase shift oscillator, Wien bridge oscillator. (Relevant problems).

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **RBT Level:** L1, L2, L3

Module-3

Voltage Regulators: Introduction, Series Op-amp regulator, IC voltage regulators, 723 general purpose regulators, switching regulator.

Active filters: First and Second order LPF, First and Second orders HPF, Band Pass Filters, Band Reject filters. (Design examples).

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **RBT Level:** L1, L2, L3

Module-4

555 Timer: Description of Functional Diagram, Monostable operation, Applications of Monostable Multivibrator: Frequency Divider & Pulse Width Modulation. Astable operation, Applications of Astable Multivibrator: FSK Generator and Pulse Position Modulation.

Phase Locked Loops: Basic Principles, Analog phase Detector/comparator, Voltage controlled oscillator, PLL applications: Frequency Multiplication/Division, Frequency translation, FM demodulation

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **RBT Level:** L1, L2, L3

Module-5

Data Acquisition Systems: Types of instrumentation systems, Components of analog data acquisition system, Digital data acquisition system.

Data Converters:

Digital to Analog Converters: Basic DAC techniques, Weighted Resistor DAC, R – 2R Ladder DAC, DAC 0800 (Data sheet: Features and description only).

Analog to Digital Converters: Functional diagram of ADC, Flash ADC, Counter type ADC, Successive approximation ADC, Dual slope ADC. ADC 0809 (Data sheet: Features, specifications and description only), DAC/ADC specifications.

Teaching-Learning Process	Chalk and talk method, You Tube Videos, Power Point Presentation. **RBT Level:** L1, L2, L3

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

1. Understand the basic principles and operation of op-amp.
2. Design and develop basic op.amp. circuits
3. Design and develop op.amp. circuits to meet the practical applications
4. Design regulator circuits and filter circuits
5. Understand the operation and applications of 555 timer and PLL
6. Understand data acquisition system components and implement the op-amp circuits in electronic gadgets.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour**)

19. First test at the end of 5th week of the semester
20. Second test at the end of the 10th week of the semester
21. Third test at the end of the 15th week of the semester

Suggested Learning Resources:

Text Books

1."Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4th edition, Reprint 2010, New Age International. (Module -1,2,3,4 & 5)

2."Op - Amps and Linear Integrated Circuits", Ramakant A. Gayakwad, 4th edition, PHI (Module-3)

3."A course in Electrical & Electronic Measurements & Instrumentation", A K Sawhney, Dhanpat Rai Publications, 19th edition, 2011.(Module-5)

Reference Books:

1."Operational Amplifiers and Linear Integrated Circuits", Robert. F. Coughlin & Fred. F. Driscoll, PHI/Pearson, 2006

2."Op - Amps and Linear Integrated Circuits", James M. Fiore, Thomson Learning, 2001

"Design with Operational Amplifiers and Analog Integrated Circuits", Sergio Franco, TMH, 3e, 2005

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quizzes
- Surprise Tests
- Assignments
- Seminars

IV Semester

SIGNAL CONDITIONING AND DATA ACQUISITION CIRCUITS LAB			
Course Code (PCC Lab)	**21EI/BM L46**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	03

Course objectives: This laboratory course enables students to

- Understand the working of opamp. as amplifier, inverter and scale changer
- Realize and test amplifier and oscillator circuits for the given specifications
- Implement filtering circuits for signal processing applications
- Realize the opamp circuits for the applications such as DAC, implement mathematical functions

Sl.NO	Experiments
1	Design and implement Inverting Amplifier, Non-Inverting Amplifier and Voltage Follower
2	Realize Full wave Precision rectifier using op.amp.
3	Design and implement Butterworth Second order Low-pass filter
4	Design and implement Butterworth Second order High-pass filter
5	To design and implement RC Phase shift oscillator
6	To design and implement Wein Bridge oscillator
7	To design and implement Astable Multivibrator using 555 timer
8	To realize Sample and Hold circuit using discrete components
9	To design and implement 4 bit R-2R DAC using discrete components
10	Implement 8-bit DAC using IC DAC 0800 IC
11	Implement 8-bit ADC using ADC 0809 IC
12	Implement 3 bit Flash ADC using ICs

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. Sketch/draw circuit schematics, construct circuits on breadboards, analyze and troubleshoot circuits containing Op-amps, resistors, diodes, capacitors and independent sources.
2. Memoriz eand reproduce the manufacturer's data sheets of IC 555 timer, IC µa741 op-amp and data converters like IC ADC 0800 and IC DAC 0809.
3. Design and evaluate analog integrated circuits like Amplifiers, Oscillators, Active filters, Precision Rectifiers and Voltage level detectors, and compare the experimental results with theoretical values.
4. Demonstrate and analyze the working of Sample-Hold, Programmable gain amplifier and Analog Multiplexer circuits in data acquisition system.

- Design and evaluate different resolution data converters using discrete components and ICs.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

1."Linear Integrated Circuits", D. Roy Choudhury and Shail B. Jain, 4th edition, Reprint 2010, New Age International. (Module -1,2,3,4 & 5)

2."Op - Amps and Linear Integrated Circuits", Ramakant A. Gayakwad, 4th edition, PHI (Module-3)

3."A course in Electrical & Electronic Measurements & Instrumentation", A K Sawhney, Dhanpat Rai Publications, 19th edition, 2011.(Module-5)

4."Operational Amplifiers and Linear Integrated Circuits", Robert. F. Coughlin & Fred. F. Driscoll, PHI/Pearson, 2006

5."Op - Amps and Linear Integrated Circuits", James M. Fiore, Thomson Learning, 2001

"Design with Operational Amplifiers and Analog Integrated Circuits", Sergio Franco, TMH, 3e, 2005

IV Semester

PROGRAMMING IN MATLAB			
Course Code (AEC Lab)	**21EI/BM481**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0::2:0	SEE Marks	50
Credits	01	Exam Hours	2

Course objectives:

1. Preparation: To prepare students with fundamental knowledge/ overview in the field of basic signal. Processing computations.

2. Core Competence: To equip students with a basic foundation in mathematics fundamentals required for comprehending the operation and application of signal processing.

3. Professionalism & Learning Environment: To inculcate in students an ethical and professional attitude by providing an academic environment inclusive of effective communication, teamwork, ability to relate engineering issues to a broader social context, and life-long learning needed for a successful professional career..

Sl.NO	Experiments
1	Programs on basic algebra functions.
2	Programs on basic operations of vector.
3	Programs on basic operations of matrix.
4	Program to generate discrete waveforms.
5	Program to perform basic operation on signals.
6	Program to perform convolution of two given sequences.
7	Program to perform correlation of two given sequences.
	Demonstration Experiments (For CIE)
9	Verify sampling theorem.
10	Demonstrate Amplitude Modulation

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. Understand the basics of Linear Algebra
2. Analyse different types of signals and systems
3. Analyse the properties of discrete time signals & systems

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

Digital Signal Processing Using MATLAB, John G Proakis and Vinay K Ingle, Cengage Learning, 2011

IV Semester

BIOINSTRUMENTATION			
Course Code	21BM482	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Gain the knowledge of basics of Biomedical instrumentation.
- Acquire the knowledge of clinical measurements of molecules.
- To understand the measurements on blood components and measurements of body temperature, fat and movement.

Teaching-Learning Process (General Instructions)

These are sample strategies, which teacher can use to accelerate the attainment of the various course outcomes.

19. In addition to the traditional lecture method, innovative teaching methods may be adopted so that the delivered lesson shall enable the students to attain the outcomes.
20. Show videos/animations to explain the fundamental concepts and working of instruments/ transducers.
21. Encourage collaborative (Group) learning in the class.
22. Ask higher order thinking questions in the class, which promotes critical thinking.
23. Adopt Problem Based Learning (PBL), which fosters students' analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
24. Introduce the topics in a manifold representation.
25. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
26. Discuss how concepts can be applied to the real world problem to enable the students to develop appropriate skills.
27. Adopt flipped class technique by sharing the materials / sample videos prior to the class and have discussions on the that topic in the succeeding classes.

Module-1

Block diagram of a medical instrumentation system, Challenges faced with physiological measurements. Medical instrument specifications. Biopotential electrodes: Electrode-Electrolyte Interface, Half-cell potential, Offset Voltage. External, Internal and Microelectrodes. Equivalent circuit and applications of biopotential electrodes. Basic requirements for the display and recording of Biopotential signals. Classification of recorders, PMMC writing systems. General features of ink-jet, thermo-sensitive and optical recorders. Array recorders.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-2

Analysis of molecules in clinical medicine:

Spectrophotomerty, Amperometric biosensors for oxygen and glucose, flame photometry, mass spectrometry, Drugs by fluorometry and chromatography, electrophoresis, and DNA sequencing, blood gas analyzer, Electrolyte Analyser, Semi and fully automated analyzers

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-3

Hematology:

Blood components and processing, RBC count, WBC count, hemocytometer, Blood Cell Counters-Microscopic and Automatic methods. Coulter Counter, Portable Coulter counters Handheld and Point-of-Care testing. Automatic differential counting of cells. Complete blood cell count.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-4

Working principle and types of Nebulizer, Suction apparatus. Fluid warmer, Fumigation, Oxygen concentrator. Oximeters-Ear, pulse, skin reflectance and intra vascular types.

Cellular measurement: Light microscopy, cell orientation, TEM, SEM, cell differentiation, cell signaling and regulation.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Module-5

Body temperature, heat, fat and movement.

Regulation of body temperature, clinical temperature measurement, Calorimety-Direct and indirect. Measurement of body fat- direct and indirect. Measurement of body movement-Goniometer, Accelerometer, video and optoelectronic systems.

Teaching-Learning Process	Chalk and Talk, Power Point Presentation, YouTube videos and animations, flipped classroom.

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

1. Identify various types of bioinstruments suitable for biomedical measurement.
2. Understand construction, working principle of basic biomedical instrument
3. Comprehend different types of clinical instruments and analyzers, their construction and operation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

4. First test at the end of 5th week of the semester
5. Second test at the end of the 10th week of the semester
6. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

3. First assignment at the end of 4th week of the semester
4. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Textbooks:

1. Bioinstrumentation – John G. Webster, John Wiley and Sons, Inc. 2004.
2. Biomedical Instrumentation and Measurement – Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer,2nd Edition, Prentice-Hall India Pvt. Ltd., 2004.

Reference Books:

1. Transducers and Instrumentation -D. V. S. Murty Prentice Hall India Pvt ltd. 2nd Edition Biomedical Transducers and Instruments – Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.
2. Handbook of Biomedical Instrumentation- R S Khandpur, 2nd edition, Tata McGraw Hill, 2003

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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IV Semester

SIGNAL CONDITIONING LAB USING PSPICE / MULTISIM			
Course Code (AEC Lab)	**21EI/BM483**	CIE Marks	50
Teaching Hours/Week (L:T:P:S)	0:0:2:0	SEE Marks	50
Credits	01	Exam Hours	02

Course objectives:

- To learn the linear and non-linear applications of operational amplifiers
- To understand the fundamentals of ADC and DAC conversion techniques
- To use Multisim /Pspice software for circuit design .

Sl.No	Experiments using Pspice / MultiSIM Every experiment has to be designed, circuit to be drawn / constructed and executed in thespecified software. Results are also to be noted and inferred.
	Note: Standard design procedure to be adopted.
1	To realize using op-amp an Inverting Amplifier and Non-Inverting Amplifier
2	To realize using op-amps i) Summing Amplifier ii)Difference amplifier
3	To realize using op-amps an Instrumentation Amplifier
4	To realize using op-amps i) Differentiator ii)Integrator
5	To realize using op-amps a Full wave Precision Rectifier
6	To realize using op-amp an Inverting Schmitt Trigger
7	To design and implement using op-amps • Butterworth I & II order Low Pass Filter • Butterworth I & II order High Pass Filter
8	To design and implement using op-amp an RC Phase Shift Oscillator
9	To realize using op-amp an Astable Multivibrator
10	To design and implement Mono-stable Multivibrator using 555 timer
11	To design and implement an 8- bit Successive approximation Analog to Digital converter.
12	To design and implement 4 - bit R-2R Digital to Analog Converter

Course outcomes (Course Skill Set):

After studying this course, students will be able to;

1. Sketch/draw circuit schematics, construct circuits, analyze and troubleshoot circuits containingop-amps, resistors, diodes, capacitors and independent sources.
2. Relate to the manufacturer's data sheets of IC 555 timer and IC μa741 op-amp.
3. Realize and verify the operation of analog integrated circuits like Amplifiers, Precision Rectifiers, Oscillators using Pspice.
4. Analyze the performance of filters, multivibrators, ADC and DAC using Pspice.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination (SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8^{th} weekof the semester and the second test shall be conducted after the 14^{th} week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, 4^{th} Edition, Pearson Education, 2018.

IV Semester

BIOELECTRIC PHENOMENA			
Course Code	21BM484	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- Gain the knowledge of Electrophysiology.
- Acquire the knowledge of Electrical Conductivity of biological tissues.
- To understand Computational Methods and Software used in Bioelectric Field.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

9. Understand the balance between electric field and diffusion forces that develop in the selectively permeable membrane of excitable cells.
10. Learn to appreciate the balance of ionic currents and the contributions of channel gating in the initiation and maintenance of the action potential.
11. Generate computer programs that simulation action potentials in single cell and multicellular preparations.
12. Relate spatial currents to membrane currents to appreciate the contribution of the extracellular space to propagation, responses to electrical stimulation and experimental recordings.

Module-1	
Basic Electrophysiology: Galvani and Scientific Electrophysiology, The Electrical Structure of Active Membrane, Patches, A Mathematical Model of the Patch, Energy and the Resting Potential, Membrane Stimulation, Action Potentials and Membrane Currents in a Patch, Resting Phase, Stimulation Phase, Excitation Phase, Recovery Phase , Action Potential Wave Forms following Patch, Stimulation, Resting Phase, Stimulation Phase, Excitation Phase, Recovery Phase, End Repolarization Propagation, Comparative Transmembrane Potentials, Intracellular Current Flow, Membrane Current, Extracellular Path, Propagation Velocity, Two and Three Dimensions, Field Stimulation, Galvani in Hindsight, Magnetics.	
Teaching-Learning Process	
Module-2	
Volume Conductor: Theory Basic Relations in the Idealized Homogeneous Volume Conductor, Monopole and Dipole Fields in the Uniform Volume of Infinite Extent, Volume Conductor Properties of Passive Tissue, Effects of Volume Conductor In homogeneities: Secondary Sources and Images.	
Teaching-Learning Process	.
Module-3	
Electrical Conductivity of Tissues Introduction: Cell Suspensions Fiber Suspensions Syncytia Cardiac Microimpedances: Introduction Microimpedances Derived from Literature-Based Data Impact of Micro-impedance Measurement Availability , Multisite Stimulation for Micro-impedance Measurements	
Teaching-Learning Process	
Module-4	
Membrane Models: General Formulations of Membrane Currents, Nernst–Planck Equations, Hodgkin–Huxley Resistor Battery Model, Goldman–Hodgkin–Katz Constant Field Formulation, GHK with Correction for Fixed Surface Charge, Eyring Rate Theory Models of Ionic Currents, Ion Pump, Ion Exchangers, Synapses, Calcium as a Second Messenger, Nerve Cells Sensory Neurons, Efferent Neurons , Skeletal Muscle CellS, Cardiac Cells Purkinje Fiber, Sinoatrial Node, Atrial Muscle, Atrioventricular Node, Ventricular Muscle, Atrial Cells, Epithelial Cells, Smooth Muscle, Simplified Models Hill, Fitz Hugh–Nagumo, Hindmarsh–Rose Models	
Teaching-Learning Process	

Module-5	
Computational Methods and Software for Bioelectric Field Problems: Introduction, Problem Formulation with examples, Model Construction and Mesh Generation Numerical Methods Approximation Techniques- The Galerkin Method, Finite Difference Method, Finite Element Method, Boundary Element Method, Solution Methods and Computational Considerations, Comparison of Methods Adaptive Methods Convergence of a Sequence of Approximate Solutions, Software for Bioelectric Field Problems	
Teaching-Learning Process	

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

1. Understand the working principle and construction details of Transducers.
2. Improve the measurement techniques through different approach.
3. Practically can implement the technology in measurement field.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour**)

7. First test at the end of 5th week of the semester
8. Second test at the end of the 10th week of the semester
9. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

5. First assignment at the end of 4th week of the semester
6. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. The Biomedical Engineering Handbook fourth edition, by Joseph D. Bronzino and Donald R. Peterson, CRC Press, 2015.
2. Sensors, Nanoscience, Biomedical Engineering, and Instruments, by Richard C. Dorf, CRC Press, 2015.

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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