IIT Palakkad

UG Curriculum 2022

BTech Electrical Engineering

Applicable to all from 2022-23 Academic Year

21 April, 2022

The UG Curriculum and Sample Template for Electrical Engineering

Program : **Bachelor of Technology**

Department : **Electrical Engineering**

Year : **2022 Onwards**

The Department of Electrical Engineering is diverse with specializations spanning across core electrical engineering, electronics engineering, communication engineering, and instrumentation engineering. The BTech Electrical Engineering program envisages to provide a platform for students to build their careers/knowledge in these varied fields of electrical engineering. The program aims at breadth through the sufficient number of core courses in these varying domains, and a wide list of electives to enable students to achieve depth in desired sub-areas. Further, to emphasize practical learning, almost all core courses are integrated with a lab/practice component. The core courses are listed below:

Level 1	Level 2	Level 3
Digital Systems (4) Electrical and Magnetic Circuits (3) Signals and Systems (3) Solid State Devices (3) Engineering Electromagnetics (4)	Control Engineering (4) Analog Circuits Theory and Lab (4) Microprocessor Systems Design and Interfacing (4) Digital Signal Processing (3) Principles of Communication (4) Electrical Machines (4) Measurements and Instrumentation (4)	Power Systems (4)

Note: Level 1 courses require no prerequisites, Level 2 courses require some prerequisites from Level 1, whereas Level 3 courses require some prerequisites from Level 2.

Tentative list of program electives in various wide-ranging sub-areas are listed below:

Devices, VLSI and RF
Principles and Design of MEMS, CMOS Analog and Digital Circuits, VLSI Architectures for Signal Processing and Machine Learning,RF Remote Sensing Systems, Nanoelectronic Devices, RF and Microwave Active Circuits, RF and Microwave Passive Circuits, Principles and Design of MEMS
Communication and Signal Processing
Information Theory and Statistics*, Biomedical Instrumentation and Signal Processing, Information Theory and Coding, Wireless Communications, Digital Image Processing
Power Electronics, Power Systems and Machines
Power System Protection, Power Systems Analysis and Operation*, Power Converter Analysis and Design, Power Converters - Modulation Control and Applications, Electrical Machines Analysis and Modeling, Renewable Energy Systems*, Electric Drives*
Control Systems and Instrumentation
Synthesis of Control, Control of Nonlinear Dynamical Systems, Sensors and Signal Conditioning, Optimal Control, Reinforcement Learning based Control, Robot Implementation Methods, Advanced Sensors Laboratory
General Courses
Linear Algebra for Engineers*, Computational Methods in Electrical Engineering

*PG level courses, can be taken by UG Dual Degree

The curriculum provides flexibility to the students to credit courses in a sequence determined by prerequisites. While several sequences could be possible, one plan is presented with a few illustrations on combinations of electives and projects.

BTech Electrical Engineering 2022 onwards (Sample Template)[1]					
Sl No.	**Semester**	**Course Code**	**Course Title**	**Category**	**Credits**
1	I	PH1030	Physics	Institute Core	2-1-0-3
2		MA1011A	Linear Algebra and Series	Institute Core	3-1-0-4
3		ME1130	Engineering Drawing	Institute Core	1-0-3-3
4		ES1010	Ecology and Environment	Institute Core	2-0-0-2
5		ID1050A	Engineering Design	Institute Core	1-0-3-3
6		ME1150	Mechanical Workshop	Institute Core	0-0-3-2
7		PH1130/ CY1140	Physics/Chemistry Lab	Institute Core	0-0-3-2
			Total		**19**
Sl No.	**Semester**	**Course Code**	**Course Title**	**Category**	**Credits**
1	II	MA1021	Multivariable Calculus	Institute Core	3-1-0-4
2		CY1040	Basic Chemistry for Engineers	Institute Core	2-1-0-3
3		HS1010	Technology and Society	Institute Core	2-0-0-2
4		CE1020	Engineering Mechanics	Institute Core	3-1-0-4
5		ID1110	Introduction to Programming	Institute Core	2-0-3-4
6		EE1110	Electrical Workshop	Institute Core	0-0-3-2
7		PH1130/ CY1140	Physics/Chemistry Lab	Institute Core	0-0-3-2
			Total		**21**
Sl No.	**Semester**	**Course Code**	**Course Title**	**Category**	**Credits**
1	III		Science and Mathematics Elective 1	SME	3
2		EE2070	Digital Systems	PMC	3-0-2-4
3		EE2030A	Electrical and Magnetic Circuits	PMC	3-0-0-3
4		EE2050A	Signals and Systems	PMC	3-0-0-3
5		EE3010A	Solid State Devices	PMC	3-0-0-3
6		EE2060A	Engineering Electromagnetics	PMC	3-0-2-4
			Total Credit		20
Sl No.	**Semester**	**Course Code**	**Course Title**	**Category**	**Credits**
1			Science and Mathematics Elective 2	SME	3

[1] The detailed syllabi of the courses can be found in Annexure 6

2	IV		Humanities and Social Sciences Elective 1	HSE	3
3		EE3060A	Control Engineering	PMC	3-0-2-4
4		EE2040A	Analog Circuits Theory and Lab	PMC	3-0-2-4
5		EE2080	Microprocessor Systems Design and Interfacing	PMC	3-0-2-4
6		EE3020A	Digital Signal Processing	PMC	3-0-0-3
			Total Credits		**21**

Sl No.	Semester	Course Code	Course Title	Category	Credits
1	V	EE3030A	Measurements and Instrumentation	PMC	3-0-2-4
2		EE3050A	Principles of Communication	PMC	3-0-2-4
3		EE2020A	Electrical Machines	PMC	3-0-2-4
4		BT2010	Life Sciences	Institute Core	2-0-0-2
5			Open Elective 1	OE	3
6			Program Major Elective 1	PME	3
7			Program Major Elective (for Honours)	PME*	3
			Total Credits		**20/23**

Sl No.	Semester	Course Code	Course Title	Category	Credits
1	VI	EE3040A	Power Systems	PMC	3-0-2-4
2			Program Major Elective 2	PME	3
3			Program Major Elective 3	PME	3
4			Open Elective 2	OE	3
5			Open Elective 3	OE	3
6			Project[#]	Project	3(0)
			Total Credits		**19(16)**

[#]Flexibility is illustrated through different Project combinations and are elaborated below

Sl No.	Semester	Course Code	Course Title	Category	Credits
1	VII		Program Major Elective 4	PME	3
2			Program Major Elective 5	PME	3
4			Humanities and Social Sciences Elective 2	HSE	3
5			Open Elective 4	OE	3
6			Program Major Elective* (for Honours)	PME*	3
7			Program Major Elective* (for Honours)	PME*	3
8			Project[#]	Project	0(3)

			Total Credits		**12(15)/18(21)**
[#]Flexibility is illustrated through different Project combinations and are elaborated below					
Sl No	**Semester**	**Course Code**	**Course Title**	**Category**	**Credits**
1	VIII		Humanities and Social Sciences Elective 3	HSE	3
2			Open Elective 5	OE	3
3			Program Major Elective* (for Honours)	PME*	3
4			Project[#]	Project	6(3)
			Total Credits		**12(9)/15(12)**
[#]Flexibility is illustrated through different Project combinations and are elaborated below					

Total Credits	
Institute Core (IC)	42
Program Major Core (PMC)	48
Program Major Elective (PME)	15
Humanities and Social Sciences Elective (HSE)	9
Sciences and Mathematics Elective (SME)	6
Open Elective (OE)	15
Project	9

Option - 1	Project (3-credits)	Project (3-credits)	Project (3-credits)
	Semester VI	Semester VII	Semester VIII
For Project: (Total 9 Credits)			
Option - 2,3	Project (3-credits)		Project (6-credits)

Only a few combinations are illustrated here, the students can credit Project starting from 5th semester also

Electrical Engineering

Core course Syllabi

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (New)

Course Title : Digital Systems
Course Code : EE2070
Credit : 3-0-2-4 (L-T-P-C)
Category : Core
Target Programme : UG core
Target Discipline : EE
Prerequisite (if any) :
Date of proposal : 15-11-2021
Date of approval :
Proposing faculty : Dr. Subrahmanyam Mula

Course Content:

S. No.	Topic	Lecture (hours)	Practical (hours)
1	Introduction to Digital systems and Boolean Algebra : Binary, octal and hexadecimal number systems; Basic logic operation and logic gates; truth table; basic postulates and fundamental theorems of Boolean Algebra; Canonical (SOP and POS) forms; Logic minimization and implementation : Minterm and Maxterms; Karnaugh maps; incompletely specified functions; NAND and NOR implementations; Switch level representation using transistors using CMOS	9	0
2	Combinational Logic: Decoder, encoders, multiplexers, demultiplexers and their applications; Arithmetic circuits; Representation of signed numbers; Adders -- ripple carry, carry look ahead, BCD adders	11	6
3	Sequential Logic : Latches and flip flops D latch, D flipflop, Setup and hold parameters; Timing analysis; Registers and counters; Shift register; Synchronous counter design using D and JK flipflops, State Machine Design : Definition of state machines; State machine as a sequential controller; Moore and Mealy state machines; Derivation of state graph and tables; Sequence detector; Design state machine using ASM charts;	12	3

4	Memory and Programmable Logic Devices: Read Only Memories FPGAs; Hardware description language: Modeling combinational and sequential circuits using Verilog.	10	12
	Total	42	21

Learning Outcomes:

1. Understand digital system abstractions such as digital representations of information, digital logic, Boolean algebra, state elements and finite state machine
2. Design, build and test digital logic for systems of moderate complexity using common digital components, schematic diagrams, and hardware description language

List of Experiments:

1. Basic AND, OR and Inverter gates and a parity generator on a bread board
2. Half adder and full Adder circuits on a bread board
3. 4-bit binary counter design using flip flops on a bread board
4. 4-bit adder design using Verilog hierarchical design, test bench, simulation and FPGA implementation
5. Traffic light controller design using Verilog hierarchical design, test bench, simulation and FPGA implementation
6. Accumulator circuit design in Verilog hierarchical design, test bench, simulation and FPGA implementation
7. Fibonacci series generation on an FPGA using two adders and a register.

Text Books:

1. Digital Design With an Introduction to the Verilog HDL, VHDL, and SystemVerilog, Pearson Education; Sixth edition, 2018 ISBN 978-9353062019

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (Revised)

Course Title	:	**Electrical and Magnetic circuits**
Course Code	:	EE2030A
Credit	:	3-0-0-3 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	EE
Prerequisite (if any)	:	
Date of proposal	:	November 29 2021
Date of approval	:	
Proposing faculty	:	Dr. Anirudh Guha, Dr. Vijay Muralidharan, Dr. Shaikshavali Chitraganti

Course Content:

S/N	Topic	Lecture (hours)
1	Current Source, Voltage Source, Resistor, Inductor, Capacitor, Passive Sign Conventions, Controlled current source and voltage source	3
2	KVL, KCL, Voltage and current division, Equivalent series and parallel, Nodal Analysis, Mesh Analysis, Source transformations, Thevenin and Norton equivalent circuits, Superposition theorem, Max power transfer theorem	9
3	Complete response of RC, RL with dc excitation - transient response and steady state analysis, Analysis of series and parallel RLC circuits	12
4	AC analysis: Phasors, Phasor Diagrams, Resonance, Complex power; real(average) power, reactive power, apparent power, power factor, conjugate matching for maximum power transfer	6
5	Basics of three-phase systems, 3 and 4 wire connection; Delta and star connected loads; Star-Delta transformation; Balanced and unbalanced loads, Power calculations in three-phase systems	6
6	Basics of Magnetic circuits: MMF, ampere's circuital law, reluctance, magnetic equivalent circuit and equivalence with electric circuit, inductance, overview of BH curve, Overview of a coupled circuit	3
7	Ideal Opamp : Negative and positive feedback and examples	3
	TOTAL	42

Learning Outcomes:

At the end of the course, students should be able to analyze the circuits with appropriate techniques introduced in this course.

Text Books: (*Include ISBN Numbers*)

1. Engineering Circuit Analysis by William H. Hayt, Jack Kemmerly, Steven M. Durbin. McGraw Hill Education, Eighth edition, 2013. ISBN-10: 125909863X, ISBN-13: 978-1259098635
2. Electric circuits by James W Nilsson and Susan A. Riedel, Pearson, 11th edition, 2018, ISBN-10: 0134746961

Reference books:

1. Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N. O. Sadiku, McGraw Hill Education, Fourth edition, 2008. ISBN-13: 978–0073529554, ISBN-10: 0073529559
2. Introduction to Electric Circuits by James A. Svoboda and Richard C. Dorf, ISBN-10 : 1118477502

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Proforma for proposing course (Revised)

Course Title	:	Signals and Systems[1]
Course Code	:	EE2050A
Credit	:	3-0-0-3 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	EE
Prerequisite (if any)	:	
Date of proposal	:	
Date of approval	:	
Proposing faculty	:	Dr. Swaroop Sahoo and Dr. Sneha Gajbhiye

Course Content:

Signals and Systems (continuous-time): Signal classification, standard signals, transformations of the independent variable, System classification, Impulse response of an LTI system, convolution integral and graphical, system properties from impulse response, complex exponential as eigenfunction of LTI systems, interconnection of LTI systems *[9 lectures]*

Discrete-time signals and systems: Emphasize similarities and differences with continuous-time counterpart *[6 lectures]*

Continuous-time Fourier series: Periodic signals and their properties, exponential and trigonometric FS representation of periodic signals, convergence, FS of standard periodic signals, salient properties of Fourier series, FS and LTI systems, some applications of FS *[7 lectures]*

Continuous-time Fourier transform: Development of Fourier representation of aperiodic signals, convergence, FT of standard signals, FT of periodic signals, properties of FT, some applications of FT (eg. modulation) *[7 lectures]*

Laplace Transform: Bilateral Laplace transform, region of convergence, Unilateral Laplace transform, properties of Laplace transform, standard Laplace transform pairs, transfer function of LTI system, characterizing LTI system properties from transfer function, brief introduction and application to simple initial value problems *[7 lectures]*

Sampling (Bridge continuous and discrete): Sampling theorem and signal reconstruction, notion of aliasing with examples, Sampling in frequency domain *[6 lectures]*

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Existing EE2050 course

Learning Outcomes:

Students will be able to work with various types of signals and systems both in the continuous and discrete-time form. Analyze the spectral characteristics of continuous-time periodic and non-periodic signals using Fourier series and transform, respectively. Classify systems based on their properties and determine the response. Understand the process of sampling and the effects of sampling on the signals

Text/Reference Books: (*Include ISBN Numbers*)

1. *Principles of Linear Systems and Signals* by B.P. Lathi, international edition 2009, Oxford University Press. ISBN-13: 978-0190200176
2. *Signals and Systems* by A.V. Oppenheim and A.S. Willsky, Second Edition, 1998, Prentice-Hall. **ASIN:** 9332550239
3. *Signals and Systems* by S. Haykin and B. D. Van Veen, 2002, Wiley. ISBN: 9788126512652, 9788126512652

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (Revised)

Course Title : Solid State Devices

Course Code : EE3010A

Credit : 3-0-0-3 (L-T-P-C)

Category : Core

Target Programme : UG

Target Discipline : BTech Electrical

Prerequisite (if any) :

Date of proposal : Nov 29, 2021

Date of approval :

Proposing faculty : Dr. Arvind Ajoy, Dr. Revathy P.

Course Content:

S. No.	Topic	Lectures
1	Introduction: Solids, crystals and electronic grade materials direct & indirect bandgap, elemental & compound semiconductors, 2D materials	2
2	Equilibrium carrier concentration: 1. Thermal equilibrium, steady state 2. Intrinsic semiconductor – band models (concept of hole, density of states, and Fermi level) 3. Extrinsic semiconductor – band models (density of states and Fermi level)	4
3	Excess carriers: Recombination and generation of carriers, injection level, lifetime, direct and indirect semiconductors	4
4	Carrier transport: Random motion, drift and diffusion	4
5	Procedure for analyzing semiconductor devices: Basic equations and approximations, equations of state – Continuity and Poisson equation	4
6	p-n Junction: energy band diagram, derivation of dc and ac characteristics Optoelectronic devices: LEDs, Photovoltaics, Imagers	9
7	Bipolar junction transistors	4
8	Metal-semiconductor junctions	3

9	MOS Junction: C-V characteristics, threshold voltage, body effect	4
10	Metal Oxide Field Effect Transistor: physics, characteristics and modelling	4
	Total	42

Course Objectives: This is a basic course on solid-state devices. The aim of this course is to introduce students to the electronic properties of semiconductors and semiconductor devices. They will also be introduced to the impact of solid-state device capabilities and limitations on electronic circuit performance. In the process, they will be introduced to the basic tools with which newly developed devices and other semiconductor applications can be studied.

Learning Outcomes: At the end of the course, the students should have:

1. a fundamental understanding of the factors that influence the carrier concentration in semiconductors.
2. an understanding of the behaviour of p-n junctions, MS contacts, BJT, MOS, and MOSFET devices.
3. a fundamental understanding of the influence of different materials and device design on the performance of aforementioned devices.
4. apply appropriate mathematical techniques and approximations to compute device parameters.

Text books:

1. B. G. Streetman and S. Banerjee, “Solid State Electronic Devices,” Pearson Education India; Seventh edition (2015), ISBN-10: 9332555087, ISBN-13: 978-9332555082.
2. R. F. Pierret, “Semiconductor Device Fundamentals,” Pearson 2nd edition, ISBN-10: 0201543931, ISBN-13: 978-0201543933.
3. M. S. Tyagi, “Introduction to Semiconductor Materials and Devices,” Wiley (2008), ISBN-10: 8126518677, ISBN-13: 978-8126518678.

References:

1. S. M. Sze and K. K. Ng, “Physics of Semiconductor Devices,” Wiley-Interscience, 3rd Edition, ISBN 978-0-471-14323-9.
2. Y. Taur and T. H. Ning, “Fundamentals of Modern VLSI Devices,” Cambridge University Press, ISBN-13: 9780511601538.
3. A. DasGupta and N. DasGupta, “Semiconductor Devices: Modelling and Technology,” Prentice Hall India Learning Private Limited (2004), ISBN-10: 812032398X, ISBN-13: 978-8120323988.
4. S. Karmalkar,“Solid state devices,” NPTEL video lectures: http://nptel.ac.in/courses/117106091/

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Proforma for proposing course (New/Revised/MOOC)

Course Title : Engineering Electromagnetics

Course Code : EE2060A

Credit : 3-0-2-4 (L-T-P-C)

(Weekly hours for L- lecture, T-Tutorial, P - Laboratory, C - total course credit)

Category : Core

Target Programme : UG

Target Discipline : EE

Prerequisite (if any) : Multivariable Calculus (MA1021)

Date of proposal : 29-11-2021

Date of approval :

Proposing faculty : Dr. Sukomal Dey, Dr. Swaroop Sahoo

Course Content:

Introduction to Engineering Electromagnetics: Why study Electromagnetic Waves? Application of Electromagnetic Waves. **(1L)**

Vector Analysis: Review of vector algebra, Review of cartesian, Cylindrical and spherical coordinate systems, Introduction to del Δ (operator, Use of del operator as gradient, divergence, curl). **(3L)**

Maxwell's Equations: Basic Quantities of Electromagnetics, Basic Laws of Electromagnetics, Maxwell's equation in integral and differential forms: for static fields, for time varying fields, for free space, for good conductors, for harmonically varying fields, Surface Charge and Surface Current, Boundary Condition at Media Interface. **(7L)**

Transmission Lines and Matching Networks: Introduction, Concept of Distributed Elements, Equations of Voltage and Current, Standing Waves and Impedance Transformation, Loss-less and Low-loss Transmission Lines, Power Transfer on a Transmission Line, Analysis of Transmission Line in Terms of Admittances, Graphical Representation of a Transmission Line, Impedance Smith Chart, Transmission Line Calculations with the help of the Smith Chart, Admittance Smith Chart, Applications of Transmission Line, Impedance Matching Using Transmission Lines, Lossy Transmission Lines, Measurement of Line Parameters, Various Types of Transmission Lines. **(9L)**

Uniform Plane Wave: Homogeneous Unbound Medium, Wave Equation for Time Harmonic Fields, Solution of the Wave Equation, Uniform Plane Wave, Wave Polarization, Wave Propagation in Conducting Medium, Phase Velocity of a Wave, Power Flow and Poynting Vector, Surface Current and Power Loss in a Conductor. **(8L)**

Plane Waves at Media Interface: Plane Wave in Arbitrary Direction, Plane Wave at Dielectric Interface, Reflection and Refraction of Waves at Dielectric Interface, Normal Incidence on a Layered Medium, Total Internal Reflection, Wave Polarization at Media Interface, Brewster Angle, Fields and Power Flow at Media Interface, Lossy Media Interface, Reflection from a Conducting Boundary. **(8L)**

Waveguides: Parallel Plane Waveguide, Transverse Electromagnetic (TEM) Mode, Analysis of Waveguide – General Approach, Rectangular Waveguides, Parallel Plane Waveguide (As a Limiting Case of Rectangular Waveguide), Visualization of Field Inside a Waveguide, Surface Current on the Waveguide Walls, Attenuation in a Waveguide, Cavity Resonator. **(5L)**

Lab Content (24 Hours):

1. Week-1 and Week-2: System Overview- Microwave test bench, Study of Characteristics of Reflex Klystron
1. Week-3 and Week-4: Study of V-I Characteristics of Gunn Diode
3. Week-5 and Week-6: Measurements of Frequency, Guided - Wavelength and Impedance with microwave test bench.
4.Week-7 and Week-8: Microwave network analysis using Vector Network Analyzer (VNA), Measurements of S-parameters for E-plane Tee, H-plane Tee and Magic Tee
5. Week-9 and Week-10: Determination of Coupling, Insertion Loss, Isolation and Directivity of a Directional Coupler
6. Week-11 and Week-12: Radiation Pattern & Gain of Pyramidal and Parabolic dish Antenna
Lab Assignment on numerical solutions of E.M. problems with FDTD method.

Learning Outcomes:

After the completion of the course, the students will be able to:

1. Calculate electric and magnetic fields in different coordinates for various charge and current configurations.
2. Demonstrate different aspects of plane wave in dielectric and conducting media.
3. Realize the analogy of wave with transmission line and calculate the transmission line performances.
4. Select the appropriate guiding structures for electromagnetic waves.

Text/Reference Books: (*Include ISBN Numbers*)

1. W H Hayt Jr , J A Buck, M Jaleel Akhtar., Engineering Electromagnetics, Tata McGraw Hill (2008) 9th ed. ISBN-10-9353169720
2. Kraus, J.D., Electromagnetics, McGraw Hill (2006) 5thed. ISBN-10-0072899697
3. Sadiku, M.N.O, Principles of Electromagnetics, Oxford University Press (2009) 6th ed. ISBN-10 9780199461851
4. David M. Pozar, Microwave Engineering, Wiley, 4th ed, ISBN-10-8126541903
5. Jordan, E.C. and Balmain K.G., Electromagnetic Waves and Radiating Systems, Prentice Hall of India (2008) 2nd ed, ISBN-10-0132499959

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Proforma for proposing course (Revised)

Course Title	:	**Control Engineering***
Course Code	:	**EE**3060
Credit	:	3-0-2-4 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	EE
Prerequisite (if any)	:	Signals and Systems
Date of proposal	:	November 29 2021
Date of approval	:	
Proposing faculty	:	**Dr. Sneha Gajbhiye, Dr. Shaikshavali Chitraganti, Dr. Vijay Muralidharan**

Course Content:

S/N	Topic	Lecture (hours)
1	**Introduction:** Laplace transforms, Mathematical models, state space representation, measurement, outputs, inputs, transfer functions. Examples: mass-spring-damper, simple pendulum, brush dc motor, RLC circuits.	9
2	**Open loop control:** Concept of poles and zeros, open loop response, steady state error, overshoot, settling time. Concept of stability and asymptotic stability, Routh Hurwitz criterion, parameter variation (root locus).	15
3	**Closed loop control:** Block diagram representation (reference signal, error, control, plant, sensor blocks), closed loop transfer function, Nyquist and Bode plots: Frequency domain analysis, phase margin, gain margin, stability. Non-minimum phase systems, pole-zero cancellations, lead-lag compensator, PID control.	15
4	**State space:** equilibrium points, stability of equilibrium points, controllability and observability, state feedback control.	3
5	**Lab Experiments:** DC motor speed/position control, ball on beam system, wheeled robot, robot manipulator, twin rotor helicopter.	21 (practical hours)
	TOTAL	42 + 21 = 62

List of Lab Exercises:

1. Design using Lead compensator, Lag compensator, and Lead-Lag compensator. [*3 hours*]
   The objective is to learn frequency response design methods based on Root Locus and Bode Plot to design compensators.
2. Modeling and control design of the DC motor. [*3 hours*]
   To design and study the effect of the controller gains with respect to time-response parameters.
3. Control design of a two link robot manipulator. [*3 hours*]
   The objective is to model the system in state-space and design controllers to stabilize the manipulator in desired positions as well as follow a given path.
4. Design of ball on a beam system [*4 hours*]
   Linearize the equations about the equilibrium point and derive the state-space model. Design a state-feedback model to stabilize the ball about an equilibrium position.
5. Feedback Control of Wheeled mobile robot [*4 hours*]
   Design of controller for trajectory tracking in a plane.
6. PID and LQR control of twin rotor helicopter [*4 hours*]
   Design of controller for hovering at various operating points.

Learning Outcomes:

At the end of the course, students should be able to analyze and design controllers for linear time-invariant systems

Text Books: (*Include ISBN Numbers*)

1. Automatic Control Systems. Benjamin C. Kuo, and M. Farid Golnaraghi. Vol. 9. Englewood Cliffs, NJ: Prentice-Hall, 1995. ISBN-13: 978-8126552337
2. Control system Engineering. Norman Nise, Wiley, ISBN-13: 978-8126537280, 2016.
3. Modern Control Engineering. Katsuhiko Ogata, ISBN-10: 0135891280
4. Control Systems Engineering. Nagrath, and Gopal, ISBN-13: 978-9386070111

Reference books:

1. Linear System Theory and Design, Chi-Tsong Chen, ISBN-10: 0199959579
2. Linear Systems Theory, Joao P. Hespanha, ISBN-10: 0691179573
3. Feedback Systems An Introduction for Scientists and Engineers, Karl Johan Åström and Richard M Murray, ISBN-10: 0691135762

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (Revised)

Course Title : Analog Circuits Theory and Lab

Course Code : EE2040

Credit : 3-0-2-4 (L-T-P-C)

Category : Core

Target Programme : UG

Target Discipline : BTech Electrical

Prerequisite (if any) : Electrical and Magnetic Circuits, Solid State Devices

Date of proposal : Nov 29, 2021

Date of approval :

Proposing faculty : Dr. Arvind Ajoy, Dr. Sreenath Vijayakumar

Course Content:

S. No.	Topic	Lectures
1	Applications of Diodes; Design of DC Power Supply; Zener based Shunt Regulator	4
2	Incremental linear analysis of Non-linear circuits	1
3	Feedback Biasing -- Current Mirror, Drain Feedback, Source Feedback	5
4	Common Source, Common Drain, Common Gate Amplifiers including simplified frequency response	10
5	Active load and CMOS circuits	4
6	Differential Amplifier	4
7	Properties of Operational Amplifiers	4
8	Bode plot, Impact of gain-bandwidth product on amplifier performance	4
9	Overview of Bipolar Junction Transistor Circuits	6
10	Laboratory Experiments : 1. Diode rectifier based power supply 2. I-V characteristics of MOS and BJT 3. MOS based Common Source amplifier 4. Opamp based amplifiers, integrator and differentiator circuits	Seven Experiments of 3 hours each

	5. Opamp based analog filters 6. Opamp based relaxation oscillator 7. BJT based Common Emitter, Common Collector, Common Base amplifier	
	Total	42 lecture hours and seven lab sessions

Course Objectives: This course is an introduction to analog circuits using diodes and transistors. Students will be introduced to simple diode based circuits. They will also be introduced to MOS transistors, their characteristics, techniques for biasing them, and amplifiers using them. The basic transistor amplifier stages are seen as realizations of different controlled sources using negative feedback. Small- and large-signal characteristics of each amplifier will be discussed. An overview of Bipolar transistors circuits performing similar tasks as the MOS transistor based circuits will also be covered.

Learning Outcomes: At the end of this course, students should be able to build design circuits using diodes and transistors. They should be able to recognize and analyze the basic amplifiers and biasing arrangements. Students should understand the implication of frequency response on system level performance of circuits.

Text Books:

1. Microelectronic Circuits: Theory and Applications by Adel S. Sedra, Kenneth C. Smith and Arun N. Chandorkar Publisher: Oxford; Sixth edition ISBN-10: 0198089139ISBN-13: 978-0198089131

2. The Art of Electronics, 3rd edition by Paul Horowitz and Winfield Hill Cambridge University Press. ISBN-13: 9780521809269

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (Revised)

Course Title	:	Microprocessor Systems
Course Code	:	EE2080
Credit	:	3-0-2-4
Category	:	Core
Target Programme	:	UG
Target Discipline	:	EE
Prerequisite (if any)	:	EE2070 Digital Systems
Date of proposal	:	29/11/2021
Date of approval	:	
Proposing faculty	:	Dr. Mahesh Raveendranatha Panicker

Course Content:

Lecture Hours [42]

Introduction to Microprocessor Systems: Basic components of a microprocessor based digital system, Building an 8-bit microcomputer using logic gates with emphasis on timing and control unit, Op-code fetch machine cycle, Memory read/write machine cycles, I/O read/write machine cycles *[10 hours]*

Hardware Architecture: Introduction to ARM family, Evolution of the ARM architectures, RISC Vs CISC, Von-Neumann vs Harvard architecture, Memory system design, I/O system design, Peripherals, and Interfacing. Introduction to ARM Cortex M0+ with KL25Z FRDM board *[8 hours]*

Software Architecture: Addressing modes, flags, data transfer, string instructions, arithmetic, logical and bit manipulation, program transfer, processor control instructions, interrupt processing. Assembly language programming and high-level abstraction *[6 hours]*

Interfacing: General purpose input output (GPIOs), serial communications (UART, I2C and SPI), analog-digital interfaces (ADC/DAC) *[10 hours]*

Timers and Interrupts: Nested vector interrupt control (NVIC), Interrupt service routine, Hardware-Software and Maskable-Non-maskable interrupts, Timer architecture, Compare and Capture options, Pulse Width Modulation. *[8 hours]*

Lab Hours [21]

Weeks 1, 2: Building and simulating the 8-bit microcomputer using Logisim/Verilog.

Week 3: Introduction to Emulation software (e.g. Keil uVision)

Weeks 4, 5: Assembly programming exercises. Comparison of machine compiled C code into assembly with direct assembly coding.

Weeks 6, 7, 8, 9: Interfacing experiments using GPIO, UART and ADC-DAC

Weeks 10, 11, 12: Experiments on Timer and Interrupts

Weeks 13, 14: Individual projects

Learning Outcomes:

1. Identify, select, analyse, and handle microprocessor systems, I/O devices, and their interconnects.
2. Generate and interpret machine language and high-level programming for microprocessor-based applications.

Text/Reference Books: (*Include ISBN Numbers*)

1. *Digital computer electronics* by Malvino, A.P. and Brown, J.A., 3rd Edition 2001. McGraw Hill Education India. ISBN: 9780074622353

2. *The Definitive Guide to ARM® Cortex®-M0 and Cortex-M0+ Processors.* Yiu, Joseph, 2nd edition, 2015, Newnes. ISBN: 0128032774

3. *ARM microprocessor systems: cortex-M architecture, programming, and interfacing* by Tahir, Muhammad, and Kashif Javed, 1st edition, 2017, CRC Press. ISBN: 978-1482259384

4. *Embedded systems with arm cortex-m microcontrollers in assembly language and c.* by Zhu, Yifeng, 1st edition, 2017, E-Man Press LLC. ISBN: 978-0982692660

5. *Embedded Systems Fundamentals with ARM Cortex-M Based Microcontrollers: A Practical Approach* by Dean, Alexander G., 1st edition, 2017, ARM Education Media. ISBN: 978-1911531036

6. *ARM Assembly Language: Fundamentals and Techniques* by Hohl, William, and Christopher Hinds, 2nd edition, 2014, CRC Press. ISBN: 978-1482229851

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (Revised)

Course Title : Digital Signal Processing

Course Code : EE3020A

Credit : 3-0-0-3

Category : Core

Target Programme : UG

Target Discipline : EE

Prerequisite (if any) : EEXXXX Signals and Systems

Date of proposal : November 29, 2021

Date of approval :

Proposing faculty : Dr. Jobin Francis

Course Content:

Topic	Lecture (hours)
Introduction to Digital Signal Processing: Components of a DSP system, Advantages and limitations of DSP; Review of discrete-time signals and systems.	4
Frequency Analysis of Discrete-time Signals: Discrete-time Fourier series, Properties of DTFS; Discrete-time Fourier transform, Properties of DTFT.	5
Discrete Fourier Transform: Frequency domain sampling, Properties of DFT, Circular convolution, Computational complexity of DFT, Fast Fourier Transform, Implementation issues – spectrum leakage, loss in spectral resolution.	11
z-Transform: Region of convergence, Properties of z-transform, Inverse z-transform, Solving difference equations.	5
Transform analysis of LTI systems: Frequency response, Causality, Stability, Group delay Sampling and Applications: Discrete-time processing of continuous-time signals	6
Digital Filters: Structures for finite impulse response and infinite impulse response filters, Filter design, Finite word length effects	11
Total	42

Hands-on component
Students will be given programming assignments to gain a better understanding of the theoretical concepts.

Learning Outcomes

1. Learn to sample a continuous-time signal without loss of any information and recover the signal from the samples
2. Understanding of analytical tools such as DTFT, DFT, and FFT, and ability to use them for the frequency-domain analysis of signals
3. Ability to design and implement digital filters to meet design requirements

Text/Reference Books (*Include ISBN Numbers*)

1. *Discrete-Time Signal Processing* by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall, Upper Saddle River, NJ. ISBN: 9789332535039

2. *Digital Signal Processing: Principles, Algorithms, and Applications* by John G. Proakis and Dimitris K. Manolakis, 4th edition, 2007, Prentice Hall, Upper Saddle River, NJ. ISBN: 9788131710005

3. *Digital Signal Processing - Computer Based Approach* by Sanjit Mitra, 4th edition, 2013, McGraw-Hill, New York, NY. ISBN: 9781259098581

4. *Introduction to Signal Processing* by Sophocles J. Orfanidis, https://www.ece.rutgers.edu/~orfanidi/intro2sp/orfanidis-i2sp.pdf

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (Revised)

Course Title	:	Measurements and Instrumentation
Course Code	:	EE3030A
Credit	:	3-0-2-4 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	EE
Prerequisite (if any)	:	Electrical and Magnetic circuits
Date of proposal	:	27-Nov-2021
Date of approval	:	
Proposing faculty	:	Dr. Sreenath Vijayakumar

Course Content:

S. No.	Topic	Lecture (hours)
1	Measurement Introduction; Measurement Terminology: Accuracy, Precision, bias, resolution, reliability, repeatability	3
2	Errors in measurement: error in reading, full-scale error, systematic error, random error and propagation of errors	8
3	Analog Instrumentation; Calibration and Bridges, Signal Conditioning Circuits; Voltage and Phase measurement: phase-sensitive detector; Dynamic Characteristics of Sensors/Instruments	12
4	Instrumentation Circuits; Probe compensation: Linearization circuits; Instrumentation amplifier	4
5	Digital Instrumentation: Digital Multimeter, Analog-to-Digital Converters, Digital-to-Analog Converters, Data Acquisition systems; Digital Storage Oscilloscope	6
6	Transducers - definition and classification; Basic principles and working of Strain Gauge, LVDT, Temperature Transducers, accelerometer, Instrument Transformers; Basics of resistive, capacitive, inductive transducers; photodiode, piezoelectric effect;	9

	Dynamic characteristics of sensors/instruments	
7	Laboratory experiments on: -Microcontroller-based instrumentation -Measurement of offset voltage, bias current and DC gain of operational amplifiers -Developing instrumentation for simple transducers such as strain gauges and linear variable displacement transducer -Temperature measurement using RTD and linearization of output for a quarter bridge sensor -Building virtual instruments - Analog-to-Digital (ADC) and Digital-to-Analog (DAC) converters -Design of direct digital conversion circuitries	7 Experiments of 3 hours each
	Total	42 lecture hours and 7 experimental sessions

Learning Objective:

This course aims at providing an introduction to the area of electronic measurements and instrumentation.

Learning Outcomes:

Upon successful completion, the students will be able to:

1. Compare different types of instruments and its operating principles
2. Understand the techniques of making measurements using various electronic sensors.
3. Design simple signal conditioning circuits to process the outputs from various kinds of sensors.

Text/Reference Books:

1. A Course In Electrical And Electronic Measurements and Instrumentation- A K sawhney (ISBN: 9788177001006)
2. K. Neubert, 'Instrument Transducers-An introduction to their performance and design' Oxford University press, Oxford, Second edition-2003 (ISBN: 9780195629972).
3. E. O. Doeblin 'Measurement Systems – Application and Design' McGraw –Hill Publications, Fifth Edition, 2004 (ISBN: 9780070699687).

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (Revised)

Course Title : Principles of Communication

Course Code : EE3050

Credit : 3-0-2-4

Category : Core

Target Programme : UG

Target Discipline : EE

Prerequisite (if any) : EEXXXX Signals and Systems

Recommended prior course: MAXXXX Probability, Stochastic Processes and Statistics

Date of proposal : November 29, 2021

Date of approval :`

Proposing faculty : Dr. Jobin Francis

Course Content

Topic	**Lecture (hours)**
Review of Signals and Systems: Fourier series, Fourier transform, Baseband and passband signals, Baseband equivalent of a passband signal, autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems	8
Practice: Introduction to SDR, IQ conversion, Power spectral density	4
Amplitude modulation and demodulation, modulation index, AM spectrum, bandwidth. DSB-SC modulation Angle modulation: FM and PM, Spectrum of angle modulated signals, Carson's rule, Phase locked loops, Superheterodyne receivers	8
Practice: AM and FM experiments using SDR	4
Analog-to-Digital Conversion: Sampling, Quantization, Compander, Pulse code modulation, Delta Modulation, Line Coding, PSD of line codes	8
Practice: PCM experiment using OFT kit	4
Digital Baseband Communication: Advantages of digital communication, Pulse shaping, Nyquist criterion for zero ISI, Binary and M-ary signaling, MAP, ML detection, Matched filtering, Eye diagram	10
Practice: SDR experiment on pulse shaping, matched filtering, eye diagram	4
Digital Carrier Communication: ASK, FSK, PSK, QAM; Signal-space diagram, Decision regions, SNR and BER	8

Practice: SDR-based digital communication transmitter and receiver	4
Total	42 + 20 (5 practice sessions)

Learning Outcomes

1. Understanding of the different analog and digital communication techniques
2. Ability to assess the efficiency of communication systems on the basis of performance metrics such as bandwidth, rate of transmission, BER and so on.
3. Understand the ways to model the distortions introduced by the communication medium and ways to mitigate them.

Text/Reference Books: (*Include ISBN Numbers*)

1. *Introduction to Communication Systems* by Upamanyu Madhow, Cambridge University Press; 1st edition, ISBN: 9781107022775
2. *Introduction to Analog and Digital Communications* by Michael Moher and Simon Haykin, Wiley; Second edition, ISBN: 978-8126536535
3. *Modern Digital and Analog Communication Systems* by B. P. Lathi and Zhi Ding, Oxford; Fourth edition, ISBN: 978-0198073802

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (Revised)

Course Title	:	Electrical Machines
Course Code	:	EE2020
Credit	:	3-0-2-4 (L-T-P-C)
Category	:	Core
Target Programme	:	UG
Target Discipline	:	EE
Prerequisite (if any)	:	Electric and Magnetic Circuits (EE2030)
Date of proposal	:	17-12-2021
Date of approval	:	
Proposing faculty	:	Dr. Arun Rahul S

1. Introduction (3 L)

Review of magnetic circuits, concept of self inductance, mutual inductance, leakage inductance, B-H characteristics and magnetizing current for single phase and 3 phase systems.

2. General Theory (5 L)

General concepts in electro-mechanical energy conversion, singly excited systems, doubly excited systems and torque production. Dynamical equations governing the electro-mechanical systems.

3. Constructional Aspects (12 L)

Constructional aspects of electrical machines, study of different winding types, winding distribution factor, induced emf in distributed winding and emf polygon concepts, mmf distribution, concept of stationary, pulsating and rotating magnetic fields, concept of synchronous and asynchronous operation, losses in electrical machines and efficiency

4. Steady State Analysis of Electrical Machines (16 L)

Analysis of classical electrical machines using equivalent circuits
a) Transformer
b) DC machines
c) Synchronous machines
d) Induction machines
analysing the performance characteristics of various electrical machines.

5. Speed Control Concepts of Electrical Machines (4 L)

Concepts of dc and ac motor starting methods and speed control, introduction to electric drives and control

6. Special Machines (2 L)

Introduction to special machines like BLDC, PMSM, SRM etc and its applications

7. Lab Exercises *(lab exercises will be selected to cover 18 hours)*

Introduction and familiarization of lab equipment's (3 hour session)

Experiments

a. B-H characteristics and separation of hysteresis and eddy current losses (2 hour session)

b. Estimation of parameters of a doubly excited electro-mechanical energy conversion system and modeling the dynamical system (2 hour session)

c. Stationary, rotating and pulsating magnetic fields and assembling various machines (2 hour session)

d. SC and OC test of transformer and identifying equivalent circuit parameters (2 hour session)

e. load test on transformer (2 hour session)

f. OCC of dc shunt generator and no load test running as a motor (2 hour session)

g. OCC and SC test of alternator (2 hour session)

h. No load and B-R test of Induction motor (2 hour session)

i. Starting methods of induction motor (2 hour session)

j. Load test on induction motor (2 hour session)

k. Transformer winding design, study about current and potential transformers.

Learning Outcomes:

1. Basic understanding of electrical machines and its test procedures
2. Understanding of constructional and operational aspects of classical electrical machines
3. Ability to analyze electrical machines using equivalent circuits

Text/Reference Books: (*Include ISBN Numbers*)

1. Fitzgerald, Kingsley and Umans, Electric Machinery, sixth edition, Tata McGraw Hill, New Delhi, 2002. **ISBN-10 :** 0070530394, **ISBN-13 :** 978-0070530393

2. Nagrath and Kothari, Electric Machines, Fourth edition, Tata McGraw Hill, New Delhi, 2010. ISBN: 9780070699670, 0070699674

3. Stephen J Chapman, Electric Machinery Fundamentals, Fourth Edition, McGraw Hill, Singapore 2005. ISBN 0072465239, 9780072465235

4. John Hindmarsh, Electric Machines and their Applications, Pergamon Press, London, 1977. ISBN-10 0080211658, ISBN-13 978-0080211657

INDIAN INSTITUTE OF TECHNOLOGY PALAKKAD

Proforma for proposing course (New/Revised/MOOC)

Course Title : Power Systems

Course Code : EE3040

(To be provided by the Academic Section, Level should be indicated by the proposer. Example: CE5XXX for a 5000 level course in Civil Engineering)

Credit : 3-0-2-4 (L-T-P-C)

(Weekly hours for L- lecture, T-Tutorial, P - Laboratory, C - total course credit)

Category : Core

Target Programme : UG

Target Discipline : EE

Prerequisite (if any) : Electrical & Magnetic Circuits, Electrical Machine

Date of proposal : 13-01-2022

Date of approval :

Proposing faculty : Dr. Manas Kumar Jena

Course Content:

Lecture Hours [42]

1. Review concepts of complex power, phasors **[3 hours]**
2. Evolution of Power Systems, Energy Sources Structure of Bulk Power Systems, Power System Components: Generators, Loads, Transformers, Transmission Lines, etc. Modeling, Performance, and Constraints of these components, Formulation/Solution of steady-state equations for interconnected systems, Per Unit System **[6 hours]**
3. Ybus formation, Simple example of a load-flow solution (only Gauss-Seidel) **[6 hours]**
4. A brief introduction to sequence components and their application to fault analysis **[6 hours]**
5. Introduction to generator swing equations and stability issues **[6 hours]**
6. Interconnected System Operation and Control: Operational Objectives, Frequency Control, Voltage Control **[8 hours]**
7. A brief introduction to power system protection: Relaying basics, over current relay **[4 hours]**
8. Introduction to Smart Grid: Architecture of Smart Grid Systems **[3 hours]**

Lab Sessions [21 hours]

1. Introduction to Power System Modeling using MATLAB/PSCAD/DSA Tools/PSSE [6 hours]
2. Experiment on Transmission line modeling [3 hours]
3. Power flow study using MATLAB/ DSA Tools/ PSSE [3 hours]
4. Transient Stability Study using MATLAB/ DSA Tools [3 hours]
5. Fault studies using MATLAB/PSCAD [3 hours]
6. Experiment on Automatic Generation Control [3 hours]

Learning Outcomes:

1. Get an overview of the power systems and its changing landscape.
2. Learn about control of interconnected power system
3. Learn how to calculate power flow in a power systems network.
4. Learn about rotor-angle transient stability.
5. Learn about currents in a faulted power system and protection using relays and circuit breakers.

Text Books: (*Include ISBN Numbers*)

1. Power System Analysis and Design, Sixth Edition, Duncan Glover, Mulukutla Sarma, and Thomas Overbye, Cengage Learning India, ISBN-10 : 935350208X, ISBN-13: 978-9353502089
2. Power System Analysis (1st edition ©1994), John J Grainger and W D Stevenson Jr, McGraw Hill, ISBN10: 0070612935, ISBN13: 9780070612938

Reference Books: (*Include ISBN Numbers*)

1. Electric Energy Systems Theory: An Introduction, Second Edition, Duncan Glover, Mulukutla Sarma, and Thomas Overbye, McGraw Hill, ISBN-10 : 007099286X, ISBN-13 : 978-0070992863