Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical Engineering

(NUZVID RK VALLEY SRIKAKULAM ONGOLE CAMPUS)

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

COURSE STRUCTURE AND DETAILED SYLLABI FOR THE B.TECH PROGRAM IN ELECTRICAL & ELECTRONICS ENGINEERING

(BOARD OF STUDIES APPROVED COPY)

(Effective from AY 2023-24 onwards)

CONTENTS

	(iii)	**Humanities and Social Sciences including Management courses**
		23EG1281: English-Language Communication skills Lab-1
		23EG3182: English-Language Communication skills Lab-2
		23EG3283: English-Language Communication skills Lab-3
		23HS3103:Product Design and Innovation Lab

		Mandatory Courses
		23HS3101:Indian Constitution
		23BE4101:Environmental Studies
		23HS3105:Career Development Course
	(iv)	**Program Core Courses**
		23EC2102:Digital Logic Design
		23EC2182:Digital Logic Design Laboratory
		23EE1201: Network Theory
		23EC1203:Signals and Systems
		23EC2101:Analog Electronic Circuits
		23EC2181:Analog Electronic Circuits Laboratory
		23EE2101:Electrical Machines
		23EE2181:Electrical Machines Lab
		23EE2201: Power Systems-I
		23EE2204: Machine Learning
		23EE2202:Control Systems
		23EE2282:Control Systems Lab
		23EC2203:Linear Integrated Circuits
		23EC2283:Linear Integrated Circuits Laboratory
		23EC2103: Digital Signal Processing
		23EE3101: Power Systems-II
		23EE3181: Power Systems Lab
		23EE2203: Power Electronics
		23EE2283: Power Electronics Lab
		23EE3102: Introduction to Electrical Vehicles
		23EE3182: Electrical Vehicles Lab
		23EC3126: Embedded Systems
		23EC3181: Embedded Systems lab
	(v)	**Program Elective Courses / Open Elective Courses**
		23EEXX01: Electrical Distribution System
		23EEXX02: Smart Grid Technology
		23EEXX03:Power System Protection
		23EEXX04: Power System Operation & Control
		23EEXX05: Non Conventional energy Sources
		23EEXX06: EV Batteries & Battery Management System
		23EEXX07: Fundamentals of Electric and Hybrid Vehicles
		23EEXX08: Switched Mode Power Conversion
		23EEXX09: Electric Drives

		23EEXX10: HVDC Transmission Systems
		23EEXX11: High Voltage Engineering

		23EEXX12: Industrial Electrical Systems
		23EEXX13: Digital Control Systems
		23EEXX14: Digital Signal Processing
		23EEXX15: Control Systems Design
		23EEXX16: Computer Organization and Architecture
		23EEXX17: Advanced Digital Signal Processing
		23EEXX18: Artificial Neural Networks
		23EEXX19: Bio Medical Signal Processing
		23EEXX20: Digital Image Processing
		23EEXX21: Estimation of Signals and Systems
		23EEXX23: Medical Image analysis
		23EEXX24: Pattern Recognition and Applications
		23EEXX25: Analog IC Design
		23EEXX26: Digital IC Design
		23EEXX27: Digital VLSI System Design
		23EEXX28: Electronics Systems Packaging
		23EEXX29: Embedded System Software Testing
		23EEXX30: FPGA based System design
		23EEXX31: Low Power Circuits and Systems
		23EEXX32:MEMS and Microsystems
		23EEXX33: System Verilog
		23EEXX34: VLSI DSP
		23EEXX35: VLSI physical design
		23EEXX45: Power System Protection and Switchgear
		23EEXX46: Measurements and Instrumentation
		23EEXX47: Advanced Control Systems
		23EEXX48: Renewable energy systems
		23EEXX49: HVDC and FACTS
		23EEXX50: Distribution System Planning and Automation
		23EEXX03: Power System Protection
		23EEXX51: Smart Electric Grid
		23EEXX52: Introduction to Machine Learning
		23EEXX53: AI Techniques in Electrical Engineering
		23EEXX36: Artificial Intelligence
		23EEXX37: Computational Science and Engineering using Python
		23EEXX38: Linux programming and Scripting

		23EEXX39: Robotics Operating System: Drones
	(vi)	**Seminars/Mini Projects/Projects**
		23EE3191:Mini-Project I (Socially Relevant Project)
		23EE3292:Mini Project –II
		23EE4193:Summer Internship
		23EE4194:Project-I
		23EE4295:Project-II & Dissertation
		23HS3101:Product Design & Innovation
	(vii)	**Courses being offered to other Departments**
		23EEXX41: Electrical Technology
		23EEXX42: Electrical Technology Laboratory
		23EE1201: Network Theory
		23EE2102:Control Systems

		Mandatory Courses
		23HS3102:Indian Constitution
		23BE4101:Environmental Studies
		23MC3101:Career Development Course
	(iv)	**Program Core Courses**
		23EC2102:Digital Logic Design
		23EC2182:Digital Logic Design Laboratory
		23EE1201: Network Theory
		23EC21XX:Signals and Systems
		23EC2101:Analog Electronic Circuits
		23EC2181:Analog Electronic Circuits Laboratory
		23EE2101:Electrical Machines
		23EE2181:Electrical Machines Lab
		23EE2201: Power Systems-I
		23EE2204: Machine Learning
		23EE2202:Control Systems
		23EE2282:Control Systems Lab
		23EC2203:Linear Integrated Circuits
		23EC2283:Linear Integrated Circuits Laboratory
		23EC31XX: Digital Signal Processing
		23EE3101: Power Systems-II
		23EE3181: Power Systems Lab
		23EE2203: Power Electronics
		23EE2283: Power Electronics Lab
		23EE3102: Introduction to Electrical Vehicles
		23EE3182: Electrical Vehicles Lab

		23EC31XX: Embedded Systems
		23EC31XX: Embedded Systems lab
	(v)	**Program Elective Courses/Open Electives Courses**
		23EEXX01: Electrical Distribution System
		23EEXX02: Smart Grid Technology
		23EEXX03:Power System Protection
		23EEXX04: Power System Operation & Control
		23EEXX05: Non Conventional energy Sourses
		23EEXX06: EV Batteries & Battery Management System
		23EEXX07: Fundamental of Electric and Hybrid Vehicles
		23EEXX08: Switched Mode Power Conversion
		23EEXX09: Electric Drives
		23EEXX10: HVDC Transmission Systems
		23EEXX11: High Voltage Engineering

		23EEXX12: Industrial Electrical Systems
		23EEXX13: Digital Control Systems
		23EEXX14: Digital Signal Processing
		23EEXX15: Control Systems Design
		23EEXX16: Computer Organization and Architecture
		23EEXX17: Advanced Digital Signal Processing
		23EEXX18: Artificial Neural Networks
		23EEXX19: Bio Medical Signal Processing
		23EEXX20: Digital Image Processing
		23EEXX21: Estimation of Signals and Systems
		23EEXX23: Medical Image analysis
		23EEXX23: Pattern Recognition and Applications
		23EEXX24: Analog IC Design
		23EEXX25: Digital IC Design
		23EEXX26: Digital VLSI System Design
		23EEXX27: Electronics Systems Packaging
		23EEXX28: Embedded System Software Testing
		23EEXX29: FPGA based System design
		23EEXX30: Low Power Circuits and Systems
		23EEXX31:MEMS and Microsystems
		23EEXX32: System Verilog
		23EEXX33: VLSI DSP
		23EEXX34: VLSI Physical Design

		23EEXX35: VLSI Testing and Verification
		23EEXX36: Artificial Intelligence
		23EEXX37: Computational Science and Engineering using Python
		23EEXX38: Linux programming and Scripting
		23EEXX39: Robotics Operating System: Drones
	(vi)	**Seminars/Mini Projects/Projects**
		23EE3191:Mini-Project I (Socially Relevant Project)
		23EE3292:Mini Project –II
		23EE4193:Summer Internship
		23EE4194:Project-I
		23EE4295:Project-II & Dissertation
		23XXXXX:Product Design & Innovation
	(vii)	**Courses being offered to other Departments**
		23EEXX41: Electrical Technology
		23EEXX42: Electrical Technology Laboratory

		23EEXX43: Basic Electrical & Electronics Engineering	
		23EEXX44: Basic Electrical & Electronics Engineering lab	

Chapter-1

General, Course structure, Semester-wise credit distribution

A. Definition of Credit:

1 Hour Lecture (L) per week	1 credit
1 Hour Tutorial (T) per week	1 credit
3 Hours Practical (Lab)/week	1.5 credits

B. Total number of credits: 160

C. Minimum number of contact hours/weeks per semester: 15 weeks of teaching

For 1 credit course: 15 contact hours per semester For 2 credit course: 30 contact hours per semester For 3 credit course: 45 contact hours per semester For 4 credit course: 60 contact hours per semester

D. Course code and definition, Abbreviations

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
EC	Core Courses
ECEL	Program Electives
ECP1	Project Stage-I
ECP2	Project Stage-II
ECMP1	Mini Project Stage-I
ECMP2	Mini Project Stage-II
ECSI	Summer Internship
BS	Basic Science
ES	General Engineering Courses
HS	Humanities and Social Sciences including Management Science
OE	Open Electives
MC	Mandatory Courses
PCC	Program Core Course
PEC	Program Elective Course
OEC	Open Elective Course
BSC	Basic Science Course
HSC	Humanities and Social Sciences including Management Science Course

PROJ	Mini project/Project

E.Structure of Program

S.No	Category	Credits
1	Basic Science Courses	20
2	Engineering Science Courses	24
3	Humanities and Social Sciences including Management courses	8.5
4	Program core courses	65.5
5	Program Elective courses	15
6	Open Elective courses	12
7	Project work, Miniproject work, Summer internships project	15
8	Mandatorycourses - 03 [Indian Constitution, Environmental Studies, Career Development Course]	(non-credit)
	Total	160

F. Semester-wise Credits Distribution

	TOTAL	E1-S1	E1-S2	E2-S1	E2-S2	E3-S1	E3-S2	E4-S1	E4-S2
BSC	20	10.5	6.5	3	0	0	0	0	0
ESC	24	12.5	5.5	5	1	0	0	0	0
HSC	8.5	0	2.5	0	0	2.5	1.5	0	2
PCC	65.5	0	9.5	15	23.5	17.5	0	0	0
PEC	15	0	0	0	0	0	6	6	3
OEC	12	0	0	0	0	0	6	3	3
PROJECTS/ MINI PROJ	12	0	0	0	0	1.0	1.0	4	6
SUM INTERN	3	0	0	0	0	0	0	3	0
	160	23	24	23	24.5	21	14.5	16	14

Total number of Mandatory Courses (MC): 03 (Indian Constitution, Environmental Science, Career Development Course)
*Mandatory Induction Program completes before the start of First year Semester-I.

Notations:

E1-S1: Engineering first year first semester E1-S2: Engineering first year second semester
E2-S1: Engineering second year first semester E2-S2: Engineering second year first semester E3-S1: Engineering third year first semester E3-S2: Engineering third year second semester E4-S1: Engineering fourth year first semester
E4-S2: Engineering fourth year second semester SUM INTERN: Summer Internship program

Chapter – 2

Semester-Wise Structure of Curriculum

Mandatory Induction Program

3 Weeks Duration
Physical activity Creative Arts Universal Human Values Literary Proficiency Modules Lectures by Eminent people Visit to local areas Familiarization of Dept./Branch Innovations

ENGINEERING FIRST YEAR: SEMESTER-1					
SL NO	**CATEGORY**	**COURSE CODE**	**SUBJECT NAME**	**L-T-P**	**Credits**
1	BSC	23MA1101	Differential Equations and Multivariable calculus	3-1-0	4
2	BSC	23PY1101	Engineering Physics	3-1-0	4
3	BSC	23PY1181	Engineering Physics Lab	0-0-3	1.5
4	ESC	23CE1114	Engineering Graphics & Computer Drafting	1-0-3	2.5
5	ESC	23EE1101	Electrical Technology	3-1-0	4
6	ESC	23EE1181	Electrical Technology Lab	0-0-3	1.5
7	BSC	23EE1102	Introduction to Latest Technical Advancements	1-0-0	1
8	ESC	23CS1181	Programming & Data Structures	3-1-0	3
9	ESC	23CS1182	Programming & Data Structures Lab	0-0-3	1.5
Total Credits					**23**
Total contact hours : 28 hours					

ENGINEERING FIRST YEAR: SEMESTER-2					
SLNO	**CATEGORY**	**COURSE CODE**	**SUBJECT NAME**	**L-T-P**	**Credits**
1	BSC	23MA1201	Linear Algebra & Numerical Methods	3-1-0	4
2	PCC	23EC2102	Digital Logic Design	3-1-0	4
3	PCC	23EC2182	Digital Logic Design Lab	0-0-3	1.5
4	BSC	23EE1281	Computational Lab	0-0-3	1.5
5	HSC	23EG1281	English Language communication skills lab 1	1-0-3	2.5
6	ESC	23EC1201	Electronics Devices and Circuits	3-1-0	4
7	ESC	23EC1281	Electronics Devices and Circuits Lab	0-0-3	1.5
8	PCC	23EE1201	Network Theory	3-1-0	4
9	BSC	23EE1202	Introduction to AI	1-0-0	1
Total Credits					**24**

Total contact hours : 30 hours

ENGINEERING SECOND YEAR: SEMESTER-1					
SLNO	**CATEGORY**	**COURSE CODE**	**SUBJECT NAME**	**L-T-P**	**Credits**
1	BSC	23MA2101	Probability & Random Variables	2-1-0	3
2	ESC	23EE2182	Internet of Things Lab	0-0-3	1
3	PCC	23EC2101	Analog Electronic Circuits	3-1-0	4
4	PCC	23EC2181	Analog Electronic Circuits Lab	0-0-3	1.5
5	ESC	23CS1281	Object Oriented Programming	3-1-0	3
6	ESC	23CS1282	Object Oriented Programming Lab	0-0-3	1
7	PCC	23EC1203	Signals & Systems	3-1-0	4
8	PCC	23EE2101	Electrical Machines	3-1-0	4
9	PCC	23EE2181	Electrical Machines Lab	0-0-3	1.5
Total Credits					**23**
Total contact hours: 31 hours					

ENGINEERING SECOND YEAR: SEMESTER-2					
SLNO	**CATEGORY**	**COURSE CODE**	**SUBJECT NAME**	**L-T-P**	**Credits**
1	ESC	23EE2281	Robotics Laboratory	0-0-3	1
2	PCC	23EE2201	Power Systems-I	3-1-0	4
3	PCC	23EE2204	Machine Learning	3-0-0	3
4	PCC	23EE2202	Control Systems	3-1-0	4
5	PCC	23EE2282	Control Systems Lab	0-0-3	1.5
6	PCC	23EC2203	Linear Integrated Circuits	3-1-0	4
7	PCC	23EC2283	Linear Integrated Circuits Lab	0-0-3	1.5
8	PCC	23EE2203	Power Electronics	3-1-0	4
9	PCC	23EE2283	Power Electronics Lab	0-0-3	1.5
Total Credits					**24.5**
Total contact hours : 31 hours					

ENGINEERING THIRD YEAR: SEMESTER-1					
SLNO	**CATEGORY**	**COURSE CODE**	**SUBJECT NAME**	**L-T-P**	**Credits**
1	PCC	23EC2103	Digital Signal Processing	3-1-0	3
2	PCC	23EE3101	Power Systems-II	3-1-0	4
3	PCC	23EE3181	Power Systems Lab	0-0-3	1.5
4	HSC	23EG3182	English Language communication skills Lab-2	0-0-3	1.5
5	PCC	23EE3102	Electrical Vehicles	3-1-0	3
6	PCC	23EE3182	Electrical Vehicles Lab	0-0-3	1.5
7	PCC	23EC3126	Embedded Systems	3-1-0	3
8	PCC	23EC3181	Embedded Systems Lab	0-0-3	1.5
9	PROJ	23EE3191	Mini-Project-I (Socially Relevant Project)	0-0-2	1
10	HSC	23HS3103	Product Design & Innovation lab	1-0-0	1
Total Credits					**21**
Total contact hours: 31 hours *Mini Project-1 workload not included in above workload calculation					

ENGINEERING THIRD YEAR: SEMESTER-2					
SLNO	**CATEGORY**	**COURSE CODE**	**SUBJECT NAME**	**L-T-P**	**Credits**
1	HSC	23EG3283	English Language Communication skills lab-3	0-0-3	1.5
2	PEC	23EE32XX	Elective-1	3-0-0	3
3	PEC	23EE32XX	Elective-2	3-0-0	3
4	OEC	23XX32XX	Open Elective-1	3-0-0	3
5	OEC	23XX32XX	Open Elective-2	3-0-0	3
6	PROJ	23EE3292	Mini Project-II	0-0-3	1
Total Credits					**14.5**
MC		23HS3203	Career Development Course	2-0-0	0
MC		23HS3201	Indian Constitution	1-0-0	0
Total contact hours : 21 hours *Mini Project-2 work load not included in above calculation					

ENGINEERING FOURTH YEAR: SEMESTER-1					
SLNO	**CATEGORY**	**COURSE CODE**	**SUBJECT NAME**	**L-T-P**	**Credits**
1	PEC	23EE41XX	Elective-3	3-0-0	3
2	PEC	23EE41XX	Elective-4	3-0-0	3
3	OEC	23XX41XX	Open Elective-3	3-0-0	3
4	PROJ	23EE4193	Summer Internship Project	0-0-6	3
5	PROJ	23EE4194	Project – I	0-0-8	4
Total Credits					**16**
MC		23BE4101	Environmental Science	2-0-0	0
Total contact hours : 11 hours *Project-1 work load not included in above calculation *Summer Internship Project will be after completion of Engineering Third Year Semester-2					

ENGINEERING FOURTH YEAR: SEMESTER -2					
SLNO	**CATEGORY**	**COURSE CODE**	**SUBJECT NAME**	**L-T-P**	**Credits**
1	HSC	23HS4299	Community Service	0-0-4	2
3	PEC	23EE42XX	Elective-5	3-0-0	3
5	OEC	23XX42XX	Open Elective-4	3-0-0	3
6	PROJ	23EE4295	Project-II & Dissertation	0-0-12	6
Total Credits					**14**
Total contact hours : 6 hours *Project-2 and Community Service work load not included in above calculation					

** Completion of courses through MOOCs is subjected to the regulations and guidelines of the University/Institute from time to time.
** At least two courses must be taken from Open Elective Courses

COURSES BEING OFFERED TO OTHER DEPARTMENTS

COURSE CODE	SUBJECT NAME	L-T-P	CREDITS	BRANCHES
23EEXX09	Basic Electrical and Electronics Engineering	X-X-X	X	MME, CE, CH, CSE, ME
23EEXX89	Basic Electrical and Electronics Engineering Laboratory	0-0-3	X	MME, CE, CH, CSE, ME

CHE: Department of Chemical Engineering CE: Department of Civil Engineering
CSE: Department of Computer Science and Engineering ME: Department of Mechanical Engineering
MME: Department of Metallurgy and Materials Engineering

CHAPTER 2
DETAILED 4-YEAR CURRICULUM CONTENTS SEMESTER-WISE

ENGINEERING FIRST YEAR: SEMESTER-I

23MA1101	**Differential Equations and Multivariable calculus**	**BSC**	**3L:1T:0P**	**4 credits**

Course Learning Objectives

1. Discuss the Solutions of first order differential equations.
2. Discuss the Solutions of higher order linear differential equations.
3. Understand the convergence of infinite series with different tests.
4. Learn power series representation of functions and its validity.
5. Understand Continuity and differentiability of multi-variable functions and its applications to discuss maximum and minimum.
6. Discuss the convergence Improper integrals and apply Leibnitz rule.

COURSE CONTENT

Unit – I **(10 hours)**

Differential equations of first order and first degree: Basic concepts, Variable Separable method, homogeneous differential equations, Exact differential equations, Integrating factor, Differentiable equations Reducible to exact, Linear differential equations, Bernoulli differential equations.

Unit - II **(11 hours)**

Linear differential equations of higher order: Homogenous differentiable equations, Non-homogeneous linear equations of higher order with constant coefficients with RHS term of the type eax, $sinax$, $cosax$, polynomials in x, $eax\ V(x)$, $xV(x)$, Methods of Undetermined Coefficients, Method of variation of parameters, Euler Cauchy equation

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Unit - III **(12 hours)**

Sequences and series: Definition of Sequences and convergence, Convergence of series, Comparison test, Ratio test, Root test, Absolute and Conditional convergence, Alternating series, Power series, Taylor's and Maclaurin's series.

Unit - IV **(12 hours)**

Functions of several variables: Limit, Continuity and Differentiability of functions of several variables, Partial derivatives and their geometrical interpretation, Differentials, Derivatives of Composite and Implicit functions, Chain rule, Jacobians, Derivatives of higher order, Homogeneous functions, Euler's theorem, and Harmonic functions.

Unit – V **(8 hours)**

Applications of functions of several variables: Taylor's expansion of functions of several variables, Maxima and Minima of functions of several variables - Lagrange's method of multipliers.

Unit – VI **(6 hours)**

Beta and gamma function: Beta and Gamma functions - elementary properties, Relation between Beta and gamma functions, Evaluation of Definite integral using Beta and Gamma functions, differentiation under integral sign, and differentiation of integrals with variable limits - Leibnitz rule.

LEARNING RESOURCES

TEXT BOOKS

1. ERWIN KREYSZIG**, '***Advanced Engineering Mathematics'*, Wiley-India, 9th Edition

REFERENCE BOOK

1. TOM M. APOSTAL**,***' Calculus, Volume II'*, Wiley-India, Second Edition,
2. R. K. JAIN AND S. R. K. IYENGAR,' *Advanced Engineering Mathematics'*, Narosa Publishers, 3rd Edition.
3. B.S.GREWAL**, '***Higher Engineering Mathematics'*, Khanna Publishers, 42nd Edition.

WEB RESOURCES

1. NPTEL, IIT- Madras, 08-June-2017, Introduction to ordinary differential equations URL: https://nptel.ac.in/courses/111106100/12
2. NPTEL, IIT- Kanpur, 15-March-2016, Differential Calculus of Several Variables URL: https://nptel.ac.in/courses/111104092/11
3. NPTEL, IIT- Roorkee, 23-December-2017, Multivariable Calculus URL:https://nptel.ac.in/courses/111107108/
4. MatheMagician, 24–April-2017, Calculus - sequences and series, URL: https://www.youtube.com/playlist?list=PLJMXXdEk8kMAeBLj14HX0fhe_LypRc4aW
5. RGUKT Course Content

Course outcomes: At the end of the course, the student will be able to

CO 1	Solve first order differential equations
CO 2	Solve higher order linear differential equations
CO 3	Check the convergence of infinite series and discuss the power series representation of a function at various points
CO 4	Explain limits and continuity, differentiability and partial derivatives of functions of multivariable and find the extremum of functions subjected to constraints.
CO 5	Apply Leibnitz rule and beta gamma functions to evaluate improper integrals

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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20PY1101	Engineering Physics	BS C	3L:1T:0P	4 credits

Course Learning Objectives:

1. To impart basic knowledge on the concept of vector and scalar fields as well its physical significance in all 3D coordinate systems. To integrate knowledge on vector calculus and its applications to transform 1, 2 and 3 dimensions.
2. To enable the student in detailed knowledge on Gauss's Law in electrostatics and it's applications how to calculate electric field associated by different symmetrical charge distributions. And also impart basic fundamentals on dielectric materials and induced polarizations associated by the presence of external electric field on dielectrics.
3. To impart basic idea on solving problems by using Poisson's and Laplace equations of different electrical charged bodies and also create knowledge on boundary conditions of electric fields and potentials.
4. To enhance in detail knowledge on magnetic force due to current carrying charged bodies and Amphere's law as well its applications. To integrate in detail knowledge on magnetic materials and its properties as well applications.
5. To get physical ideas contained in Maxwell's equations, and how the symmetry between changing electric and changing magnetic fields explains Maxwell's prediction of electromagnetic waves in different medium.
6. To gain fundamentals on band theory of solids, semiconductors materials its classification by Fermi energy level and band gap. To get basic knowledge on electronic devices fabricated with semiconductors, i.e. P-N diode, LED's, Photo diodes and solar cells and its working principle as well characteristics.

Course Content:

UNIT - I: Introduction (08 Hours)

Coordinate system: Cartesian, cylindrical and spherical coordinate system transformations, Differential Calculus: Gradient, Divergence, Curl and their physical significance, Integral Calculus: Line, Surface, and Volume Integrals, Integral theorem: Gauss and stokes theorems, Curvilinear Coordinates, second derivatives: Laplacian.

UNIT-II: Electrostatics -1 (09 Hours)

Coulomb's Law and Superposition Principle: Electric filed and electric dipole. Gauss's Law: Field lines and Electric flux, Applications. Electric Potential: Curl of Electric filed and Potential of localized charges, Gradient relationship between E and V. Laplace's and Poisson Equations, Electrostatic Boundary conditions, Work and Energy in Electrostatics: The energy of point charge distribution and energy of continuous charge distribution.

Basic properties of conductors. Multi pole expansions: The electric Potential and field of a dipole

UNIT-III: Electrostatics -2 **(09 Hours)**

Polarization: The Field of a Polarized object (bound charges), The electric displacement : Gauss law in the presence of Dielectrics, Linear Dielectrics (Susceptibility, Permittivity and Dielectric constant), Boundary condition and energy in Dielectric system. Capacitance, Dielectric break down. Image problems: The classical image problem, Induced surface charge

UNIT-IV: Magnetostatics **(10 Hours)**

Magnetic Force in current element : Current in a wire, surface current density, volume current density. Continuity equation ,Biot-Savart Law: Magnetic field due to wire , solenoid and Toroid. Ampere's Law,Magnetic Vector Potentials, Magnetization, magnetic susceptibility and permeability, Para ,Dia, Ferro-Magnetic material properties, Magnetic Energy, boundary conditions, Scalar & vector fields.

UNIT-V: Time varying fields **(10 Hours)**

Faraday's Law, Lenz's law, EMF, Displacement current, Maxwell's equation in vacuum and non-conducting medium and conducting medium, Energy in an electromagnetic field; Flow of energy, Poynting's theorems and conservation Laws.

UNIT-VI: Semiconductor physics **(14 Hours)**

Introduction to Quantum Mechanics: De Broglie matter waves, Uncertainty Principle, Wave function& it's probability interpretation, Postulates of quantum mechanics, Time independent Schrodinger Equation and its Applications, Particle in a box (1-D and 3-D)

Semiconductor: Electron in periodic structures, Band theory of solids, Density of states, Fermi level, Band theory of semiconductors, effective mass, Direct and indirect band gap, carriers in intrinsic and extrinsic semiconductors, Charge densities in intrinsic and extrinsic semiconductor, Law of mass action, Hall Effect.

LEARNING RESOURCES

TEXT BOOK:

1. David J. Griffiths '*Introduction to Electrodynamics'* HPI Publications, 3rd edition
2. Elements of electromagnetics by Mathews N.O. Sadiku , 3rd Edition

REFERENCE BOOKS:

1. S.L. Kakani, Subhadra Kakani '*Engineering Physics'*, CBS Publications, 2nd edition
2. Arunkumar *'Introduction to solid state physics'* HPI Publications, (30 January 2010)
3. Iswar Singh Tyagi *'Principles of quantum mechanics'* Pearson Publications; 1st edition (25 September 2012)
4. Donald Neamen *'Semiconductor devices'* McGraw Hill Education; 3ed edition (25 August 2006)

WEB RESOURCES:

1. Prof V. Ravi Shakar, NPTEL-IIT Kanpur, '*Engineering Physics-II*'
   URL: https://nptel.ac.in/courses/123104016/

2. Prof. D. K. Ghosh, NPTEL-IIT Bombay, '*Engineering Physics-II'*
   URL: https://nptel.ac.in/courses/123101002/

Course outcomes: At the end of the course, the student will be able to

CO 1	The student will have capacity to integrate knowledge on vector and scalar fields using mathematical del operators, and also solve the problems in integral calculus.
CO 2	Student will have capacity to describe the electric field and potentials associated various symmetric charged bodies by using Gauss Law. And also understand the applications of dielectric materials in real life.
CO 3	Student will be able understand different electrical charged body fields, potentials, energy density and boundary conditions by solving Poisson's and Laplace equations.
CO 4	Student will have capacity to distinguish different magnetic materials such as Dia, para and ferro (Ferri) materials and its applications.
CO 5	Student will have capacity to describe Maxwell's equation in vacuum and conducting and non-conducting media.
CO 6	Student will have capacity to describe classification of solid state materials in band theory, semiconducting materials and its significance in basic electronic devices.

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ENGINEERING FIRST YEAR: SEMESTER-I

23PY1181	**Engineering Physics Laboratory**	**BSC**	**0L:0T:3P**	**1.5 credits**

Course Learning Objectives:

1. Hall Effect: To determine the hall coefficient, carrier density and carrier mobility of a given semiconducting materials.
2. Frank Hertz: To verify the postulates of Bohr's theory and discrete (quantized) energy levels in atoms.
3. Photo electric Effect: To understand phenomenon of the photoelectric effect and Determine the value of Plank's constant.
4. Energy gap of Semiconductor: Determine the energy gap of a given semiconducting material by four probe method.
5. Susceptibility of Para Magnetic Materials: To determine the susceptibility of a given paramagnetic by Gouy's method.
6. Magnetic hysteresis curve tracer: Determine the Coercivity, Saturation magnetization and retentivity of a given Ferro magnetic material using a Hysteresis loop tracer.
7. Dielectric Constant measurement: Determine the Dielectric constant of a given dielectric material.
8. Viscosity of water Measurement: Determine the co-efficient of viscosity of given oil by falling sphere method.
9. Zener Diode experiment: Verification of I-V characteristics of Zener Diode and Determination break down voltage of Zener Diode.
10. Transition characteristic experiment: Determine different input and output parameters in common emitter configuration of both p-n-p and n-p-n Transistor.
11. Solar cell experiment: Determine the efficiency of a given Solar cell.

Experiments list

Exp-1: Hall Effect
Exp-2: Frank Hertz
Exp-3: Photo electric Effect
Exp-4: Energy gap of Semiconductor
Exp-5: Susceptibility of Para Magnetic Materials
Exp-6: Magnetic hysteresis curve tracer
Exp-7: Dielectric Constant measurement
Exp-8**:** Viscosity of water Measurement
Exp-9: Verification of I-V characteristics of Zener Junction Diode and Determination break down voltage of Zener Diode.

Exp-10: ***p-n-p*** and ***n-p-n*** Transistor parameters in common emitter configuration
EXP-11: Calculating the efficiency of Solar cell

Course outcomes: At the end of the course, the student will be able to

CO 1	Student will have capacity to measure hall coefficient of given semiconductor. Further, students can calculate carrier density and carrier mobility of a given semiconductor.
CO 2	Student will have capacity to describe discrete (Quantized) energy levels of atoms.
CO 3	Student will able to understand the photoelectric effect phenomena and then calculate Plank's constant value by using photoelectric equation.
CO 4	Student will have ability to describe the relation between conductivity and temperature in semiconductor materials and then calculate the energy gap of material.
CO 5	Student will have capable to calculate magnetic susceptibility of a given paramagnetic solution by Quinck's tube method.
CO 6	Student will able to differentiate between hard and soft ferromagnetic materials by observing B-H loops and then calculate M_s, M_r and H_c of a given ferromagnetic materials.
CO 7	Student will able to differentiate different type of dielectric mediums by calculate the dielectric constant.
CO 8	Student will have capable to calculate the co-efficient of viscosity of given oil by falling sphere method
CO 9	Student will able to understand (nonohmic) nature of I-V characteristic of Zener diode. And then calculate breakdown voltage.
CO 10	Student will able to calculate input resistance, output resistance, out the values of current and voltage gain parameters for given transistor. And also Identify the active, Saturation and cutoff regions of a given Transistors by drawing I-V characteristics.
CO11	Student will able to calculate the efficiency of solar cell.

Assessment Method

Assessment Tool	Experiments	Record	Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	5%	10%	40%
End Semester Examination weightage (%)				60%

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical Engineering

23CE1114	**Engineering Graphics and Design**	**ESC**	**1L: 0T: 3P**	**2.5 credits**

Course Learning Objective:

1. To know about emergence of Engineering Graphics as a refined communication tool and to be aware of International and national standards of practice for uniform presentation of drawings.
2. To describe the position of a point and position of the line with respect to all the planes of projection and obtain its views.
3. To learn orthographic projections of various simple plane surfaces in simple and inclined positions.
4. To know about orthographic projections of right and regular solids in simple positions, when their axes are perpendicular to one reference plane and parallel to the other.
5. To learn about types of cutting planes and to obtain views of simple solids.
6. To learn about computer aided drafting techniques and to be familiarize with one of the most powerful software 'AutoCAD'.

Course content:

Unit-I

Introduction to Engineering Drwing **(7 hours)**

Introduction toEngineeringdrawing Tools and Standards, Geometric Constructions, Scales, Conics and Special Curves - ellipse, parabola, hyperbola, cycloids,Involutes.

Unit-II

Orthographic projections **(6 hours)**

Introduction to Orthographic Projections, Projections of Points, Projection of Lines.

Unit-III

Projection of Solids **(8 hours)**

Projection of Planes, Projections of Solids cube, prism, pyramid, cylinder, cone and sphere.

UNIT-IV: Section of solids **(8 hours)**

Sections of Solids - cube, prism, pyramid, cylinder, cone and sphere. Development of Surfaces – Parallel line method and Radial line method.

UNIT-V: Introduction to AutoCAD **(8 hours)**

Computer Aided Design – Introduction to AutoCAD, Co-ordinate System (UCS) and their Commands, Basic Commands of Drawing and Editing, Dimensioning and Text.

UNIT-VI: Computer Graphics **(8 hours)**

Drawing practice with AutoCAD – Creating 2D Drawings of Objects from Isometric views, Creating Isometric views form Orthographic views and Introductions to 3D drawings.

Learning Resources

Textbooks

1. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), *'Engineering Drawing'*, Charotar Publishing House.

Reference books

1. Shah, M.B. &Rana B.C. (2008), *'Engineering Drawing and Computer Graphics'*
2. PearsonEducation. Agrawal B. & Agrawal C. M. (2012), *'Engineering Graphics'*, TMHP ublication.

Web resources

1. Prof Anupam Saxena, NPTEL-IIT Kanpur, 'Engineering Drawing'. URL:https://nptel.ac.in/courses/112104172/
2. Prof Anupam Saxena, NPTEL-IIT Kanpur, 'Computer Aided Engineering Design'. URL:https://nptel.ac.in/syllabus/112104031/

Course outcome: After the completion of this course, the student will be able to

CO 1	Student will be aware of International and national standards of practice.
CO 2	Student willbefamiliarwith obtaining the views of the frontaland the top surfaces of an object
CO 3	Student will be aware of orthographic projections of right and regular solids in simple positions, when their axes are perpendicular to one reference plane and parallel to the other.
CO 4	Student will know about computer aided drafting techniques and will be familiar with one of the most powerful software 'AutoCAD'

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	15%	40%
End Semester Examination weightage (%)			60%

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ENGINEERING FIRST YEAR: SEMESTER-I

23EE1101	**Electrical Technology**	**ESC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objectives

1. To make understand the concept of discrete electronics & electrical components and fundamental laws associated with it along with circuit laws.
2. To make understand the concept of the DC circuits using theorems
3. To make understand the concept of Single Phase and Three phase circuits
4. To make understand the concept of DC machines

Course Content

Unit-I **(12 hours)**

Circuit Concepts, R,L,C Parameters & Elements, Voltage and Current Sources, Independent and Dependent Sources, Kirchhoff's Laws, Network Reduction Techniques – Series, Parallel, Series Parallel, Star–to-Delta or Delta-to-Star Transformations, Nodal Analysis, Mesh Analysis, Super node and Super mesh for DC Excitations. (Only with Independent sources)

Unit-II **(8 hours)**

Tellegen's Theorem, Source Transformations, Superposition Theorem, Thevenins, Norton and Maximum Power Transfer Theorem.

Unit-III **(10 hours)**

Introduction to AC, calculation of R.M.S and average values. Steady State Analysis of R, L, C elements (in Series, Parallel, Series-Parallel Combinations) with sinusoidal excitation. Concept of Reactance, Impedance, Susceptance and Admittance. Phase and Phase difference, concept of Series Resonance. Concept of Power Factor, Real and Reactive powers. Complex and Polar forms of representation, Complex power.

Unit-IV **(10 hours)**

Phase Sequence- Star and Delta connection-Relation between Line and Phase Voltages and Currents in Balanced Systems-analysis of Balanced Three Phase Circuits – Phasor Diagrams-Measurement of active and reactive Power in Balanced Three Phase Systems. Two Wattmeter Method of Measurement of Three Phase Power.

Unit-V **(10 hours)**

Introduction to simple series magnetic circuits, Construction and Principle of Operation of Single Phase Transformers, on no load. Ideal and practical transformer equivalent circuits, transformer losses, transformer testing: SC and OC testing, efficiency and voltage regulation.

Unit-VI **(10 hours)**

Principles of electromechanical energy conversion and basic concepts of rotating machines. Principle of Operation of DC Machines, DC Motors, Types of Motors, Characteristics-Losses and Efficiency. Speed Control of DC Shunt Motor, Flux and Armature Voltage Control Methods. Applications of DC motors.

Learning Resources

Text Books

1. Charles Alexander and Matthew Sadiku, *'Fundamentals of Electric Circuits'*, McGraw-Hill Education; 5th edition ,2012
2. WH Hayt JE Kemmerly and S M Durbin, *'Engineering circuit analysis'*, McGraw-Hill Book Company Inc, (8th Edition), 2013.

Reference Books

1. P Kothari and I.J Nagrath, *'Basic Electrical Engineering'*, McGraw-Hill Education (3rd edition) 2010.
2. Vincent Del Toro, *'Electrical Engineering Fundamentals'*, Pearson2ndEdition.
3. Hughes, *'Electrical and Electronic Technology'*, Pearson 10/E 2011.

Web resources

1. Prof U Umanand, IISC Bangalore, *'Basic Electrical Technology'*. URL: http://nptel.ac.in/courses/108108076/
2. Prof S Aniruddhan, IIT Madras, *'Basic Electrical Circuits'*. URL: https://onlinecourses.nptel.ac.in/noc16_ee03
3. Prof Anant Agarwal, Masuchussets Institute of Technology, *'Circuits and Electronics'*. URL: https://6002x.mitx.mit.edu/courseware/6.002_Spring_2012/
4. Prof N C Jagan, RGUKT Video content, 'Electrical Technology'.

Course Outcomes

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

CO 1	Use ohms laws, Kirchhoff's laws on passive elements
CO 2	Analyze circuits made up of linear lumped elements. Specifically, analyze circuits containing resistors and independent sources using techniques such as the node method, superposition and the Thevenin's method
CO 3	Analyze the Single phase AC circuits
CO 4	Analyze the Three phase AC circuits
CO 5	Analyze DC and AC machines and
CO 6	To understand speed control techniques and power electronic applications.

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

ENGINEERING FIRST YEAR: SEMESTER-I

23EE1181	**Electrical Technology Laboratory**	**ESC**	**0L: 0T: 3P**	**1.5 credits**

Course Learning Objective:

To get a hands-on experience on the concepts in Electrical Technology theory course and thereby developing practical knowledge in analysis of electrical equipments like motors, generators etc.

List of Experiments

1. Familiarization with supply panel (AC & DC), all measuring instruments, auto transformers (1-φ and 3- φ), Name plate specifications of all machines.
2. Verification of KVL and KCL.
3. Verification of network theorems. (Superposition and Thevenin's Theorem)
4. Calibration of Single Phase Energy Meter.
5. Study the behaviors of series RLC circuit.
6. Characteristics of lamps
7. Three phase power measurement by two Wattmeter method.
8. Speed control of D.C Shunt Motor using Field and Armature control.
9. O.C. and S.C. tests on a single phase transformer
10. Lab project

Course outcome

After the completion of this laboratory course, the student will be able to

CO 1	Understand the AC and DC power supplies and their measurement practices
CO 2	Analyze the circuits using Kirchoff's voltage and current laws
CO 3	Understand the working of Energy Meter, Power measurement techniques
CO 4	Analyze the working principles of motors and generators
CO 5	Understanding the concept of loadline by experimental analysis
CO 6	Able to understand and analyze the real-time problems of Electrical Technology Applications

Assessment Method

Assessment Tool	Experiments	Record	Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	5%	10%	40%
End Semester Examination weightage (%)				60%

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ENGINEERING FIRST YEAR: SEMESTER-I

23EE1102	**Introduction to latest technological advancements**	**BSC**	**1L: 0T: 0P**	**1 credit**

Course Learning Objective

1. To know the emerging technology trends related in the Electrical & Electronics Engineering domain.
2. To know the other interdisciplinary domains connected with Electrical & Electronics Engineering.
3. To gain knowledge on the recent Industrial advancements

Course content

Exercise-I: ICT in Engineering Education (MOOCs), Interactive Education tools, Social networking for Education, ICT for societal development.

Exercise-II: Understanding the latest Mobile Phone Hardware system: Study of sensors, display, memory, processor functionality and other features.

Exercise-III: Introduction to Internet of Things (IoT), Emphasis on Electrical & Electronics field in IoT, challenges and applications.

Exercise-IV: Introduction to Artificial Intelligence, robotics and Machine learning applications and challenges.

Exercise-V: Advancements in power systems such as smart grid technology etc. Exercise-VI:

Advancements in power electronics and drive, electric vehicles, etc. Exercise-VII: Recent

advancements in VLSI and Signal Processing domains, others. Note: Invited talks by industry

experts may be arranged as part of this course.

Learning Resources

1. Magazines Electrobits magazine.
2. DRDO/ISRO/NASA Newsletters and magazines.
3. Industry newsletters and magazines

Web resources

1. NPTEL/SWAYAM/Coursera/Udemy/Flipboa apps/TED app/ Educational apps etc
2. https://spectrum.ieee.org/
3. https://www.eetimes.com/
4. https://www.digit.in/
5. https://www.ecnmag.com/
6. https://www.techdesignforums.com/

Course outcome: After the completion of this course, the student will be able to

CO 1	Understand the scope of Electrical & Electronics Engineering in real-time applications
CO2	Understand the various available resources so as to get updated with the current technology trends
CO3	Understand the current technology trends across different domains – Government sectors and Industries

Assessment Method

Assessment tool	Seminar	Report submission (End Semester)	Total
Weightage (%)	75%	25%	100%

*Note:

1. The topics in the course may vary as per the recent technical trends of the Industry. However, the changes are subject to the approval of the Institute competent authorities.
2. Industry personnel/People from ISRO/DRDO/Research Center are recommended to engage in this course.
3. In the Assessment Method, during one of the monthly seminars, the student is supposed to submit a video recording of the seminar and the same should be played in the classroom.

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ENGINEERING FIRST YEAR: SEMESTER-I

23CS1181	**Programming and Data Structures**	**ESC**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives:

1. To deduce adequate knowledge in programming language and problem-solving techniques.
2. To develop programming skills using the fundamentals of C Language.
3. To recognize the effective usage of arrays, structures, functions, pointers.
4. To implement the memory management concepts.
5. To illustrate the usage of pointers and dynamic memory allocation.
6. Explore Data Structures and its applications.

Course Content

Unit – I **(7 Hours)**

Introduction: Computer Hardware, Bits and Bytes, History of Programming Languages, Character Set, Variables and Identifiers, Built-In Data Types. Operators and Expressions, Constants and Literals, Simple Assignment Statement, Basic Input/output Statement, Simple 'C' Program, Conditional Statements and Loops.

Unit – II Arrays: **(8 Hours)**

One Dimensional Arrays, Array Manipulation, Searching, Insertion, Deletion of An Element from An Array; Finding the Largest/Smallest Element in An Array; Two Dimensional Arrays, Addition/Multiplication of Two Matrices, Transpose of square Matrix, Character Arrays.

Unit – III **(8 Hours)**

Functions: Function Declaration, Function Definition, Function Call, Call by Value, Call by Reference, Recursion, String Fundamentals, String Handling Functions.

Unit – IV **(8 Hours)**

Structure &Union: Structure Variables, Initialization, Structure Assignment, Nested Structure, Structures and Functions, Structures and Arrays: Arrays of Structures, Structures Containing Arrays, Unions.

Unit – V **(7 Hours)**

Pointer: Pointer Type Declaration, Pointer Assignment, Pointer Initialization, Pointer Arithmetic, Functions and Pointers, Arrays and Pointers, Pointer to Pointers, Dangling Memory, Dynamic Memory

Allocations, Storage Classes.

Unit – VI **(7 Hours)**

Introduction to Data Structures: Linked List, Double Linked Lists, Stack, Stack Implementation Using Arrays, Stack Implementation Using Linked List.

Text Book:

1. Reema Thareja, *'Data Structures using C'*, Oxford Higher Education,2nd Edition.

Reference Books:

1. E. BalaguruSwamy, " Programming in ANSI C", Mc Graw Hill, 7th Edition
2. Brian W. Kernighan, Dennis M. Ritchie, " The C Programming Language", Prentice Hall, 2nd Edition

Web resources

1. Prof Satyadev Nandakumar, NPTEL-IIT Kanpur, *'Introduction to Programming in C'*, URL: https://nptel.ac.in/syllabus/106104128/
2. Dr P P Chakraborty, NPTEL-IIT Kharagpur, *'Programming and Data Structures'*
   URL: https://nptel.ac.in/courses/106105085/4
   URL: https://www.tutorialspoint.com/cprogramming/

Course outcomes: At the end of the course, the student will be able to

CO 1	Illustrate the flowchart and design an algorithm for a given problem and to develop one C program using Operators.
CO 2	Develop conditional and iterative statements to write C Programs.
CO 3	Describe C Programs that use the arrays and its usage.
CO 4	Exercise user defined functions to solve real time problems.
CO 5	Describe C Programs using pointers and to allocate memory using dynamic memory management functions.
CO 6	Explore different data structures and understand.

Assessment Method

Assessment Tool	Weekly tests/Assignments (in semester)	Monthly tests (in semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING FIRST YEAR: SEMESTER-I

23CS1182	**Programming and Data Structures Laboratory**	**ESC**	**0L: 0T: 3P**	**1.5 credits**

Course Learning Objectives:

1. The purpose of the course is to introduce the students to the field of programming using C language.
2. To deduce adequate knowledge in programming language and problem-solving techniques.
3. To develop programming skills using the fundamentals of C Language.
4. To recognize the effective usage of arrays, structures, functions, pointers
5. To illustrate the usage of pointers and dynamic memory allocation.
6. Explore Data Structures and its applications.

Unit 1

Introduction

1. C Program to calculate the sum of Natural numbers.
2. C Program to find factorial of a number
3. C Program to generate a multiplication table of a given number.
4. C Program to display Fibonacci sequence (up to given number)
5. C Program to Check whether a given number is prime or not
6. C Program to make a simple Calculator using switch case
7. C Program to check whether a number is palindrome or not
8. C Program to display factors of a given number
9. C Program to print Pyramids and Triangles using loops

Unit II

Arrays

1. C Program to find second largest Element of an Array
2. C Program to add two matrix using multi-dimensional arrays.
3. C Program to multiply two matrix using multi-dimensional arrays.
4. C Program to find the transpose of a matrix.
5. C Program to Sort Elements of an Array.

Unit III

Functions

1. C Program to check whether a given number is prime or not using a user-defined function.
2. C Program to check whether a given number is Armstrong or not using a user- defined function.
3. C Program to swap two integer values using call by value and call by reference.
4. C Program to find the sum of Natural numbers using recursion.
5. C Program to find the factorial of a given number using recursion.
6. C Program to calculate length of string without using strlen() function.
7. C Program to sort elements in Lexicographical order (Dictionary order) using in built string functions.

Unit IV

Structures and Unions

1. C Program using structures to read and display the information about a student.
2. C Program to read, display, add and subtract two complex numbers.
3. C Program to read and display the information of a student using nested structure.
4. C Program, using an array of pointers to a structure, to read and display the data of students.
5. C Program to demonstrate arrays of Union variables.

Unit V

Pointers

1. C Program to demonstrate handling of pointers in C.
2. C Program to access array elements using pointers.
3. C Program to find the sum of n numbers with arrays and pointers.
4. C Program to swap two numbers using pointers and function
5. C Program to find the sum of n elements entered by the user. To perform this allocate memory dynamically using malloc() function.
6. C Program to find the sum of n elements entered by the user. To perform this allocate memory dynamically using calloc() function.

Unit VI

Introduction to Data Structures

1. Write a program to create a linked list and perform insertions and deletions of all cases. Write functions to sort and finally delete the entire list at once.
2. Write a program to create a doubly linked list and perform insertions and deletions in all cases.
3. Write a program to perform push, pop and peek operations on a stack.
4. Write a program to implement a linked stack.

References:

1. Rema Thareja, *Programming in C*, 3rd edition, Oxford Higher Education.
2. Rema Thareja, *Data structures using C*, 2nd edition ,Oxford Higher Education

Course outcome: After the completion of this Laboratory course, the student will be able to

CO 1	Apply and practice logical ability to solve the problems
CO 2	Understand C programming development environment, compiling, debugging, executing a program using the development environment
CO 3	Analyzing the complexity of problems, modularize the problems into small modules and then convert them into programs
CO 4	Understand and apply the in-built functions and customized functions for solving the problems
CO 5	Understand and apply the pointers, memory allocation techniques and use of files for dealing with variety of problems
CO 6	Understand and apply the structures and unions concept and solving problems on the same
CO 7	Understand the basic concepts of stacks, queues and applying the same for basic Problems

Assessment Method

Assessment Tool	Experiments	Record	Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	5%	10%	40%
End Semester Examination weightage (%)				60%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING FIRST YEAR: SEMESTER-II

23MA1201	**Linear Algebra & Numerical Methods**	**BSC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objectives:

1. Introduce vector spaces and linear transformation.
2. Discuss Eigen values and Eigen vectors of a matrix and various properties.
3. Setup double and triple integrals to find volume and surface area.
4. Discuss directional derivatives and application of Green's, Stokes and Gauss theorems.
5. Discuss numerical methods to find the roots of transcendental equations and Interpolation.
6. Evaluate integrals by using numerical methods and solving IVP.

Course Content:

Unit – I **(12 Contact hours)**

Linear algebra: Vector Spaces, Linear Combinations of Vectors, Linear dependence and Independence, Basis and Dimension, Linear Transformations, Matrix Representations of Linear transformation.

Unit – II **(8 Contact hours)**

Eigen values and eigen vectors: Solving system of Homogeneous and NonHomogeneous equations by using Gauss elimination method. Characteristic roots and Characteristic Vectors of a matrix - Cayley-Hamilton Theorem (without proof); Finding inverse and power of a matrix by Cayley-Hamilton Theorem.

Unit-III **(10 Contact hours)**

Multiple integrals: Double and triple integrals, computations of surface and volumes, Jacobeans of transformations, change of variables in double integrals, Change of Order of double integrals, integrals dependant on parameters - applications.

Unit–IV **(12 Contact hours)**

VECTOR CALCULUS: Scalar and vector fields, level surfaces, directional derivative, Gradient, Curl, Divergence, Laplacian, line, surface integrals and Volume integrals, Green, Gauss and Stokes theorems (without Proof) and problems.

Unit – V **(10 Contact hours)**

Root finding methods and interpolation: Roots of polynomial and transcendental equations – bisection method, Regula-Falsi method and Newton-Raphson method, Finite differences, Newton's forward and backward interpolation formulae.

Unit – VI **(8 Contact hours)**

Numerical integration and numerical solution of ivp: Trapezoidal rule, Simpson's 1/3rd rule and 3/8th rule for numerical integration, Solution of IVP by Euler and RungeKutta method

Learning resources

Text book:

1. ERWIN KREYSZIG, '*Advanced Engineering Mathematics'*, Wiley-India, 9th Edition.

Reference Books:

1. R. K. Jain and S. R. K. Iyengar**,** '*Advanced Engineering Mathematics',* Narosa Publishing House, New Delhi, 3rd Edition.
2. B.S.Grewal, '*A Text Book of Higher Engineering Mathematics'*, Khanna Publishers, 43rd Edition. Gilbert Strang , 'Linear Algebra and its Applications', CENGAGE Learning 4th Edition.

Web resources:

1. https://onlinecourses.nptel.ac.in/noc20_ma54/preview
2. https://onlinecourses.nptel.ac.in/noc21_ma11/preview
3. RGUKT content

Course outcomes: At the end of the course, the student will be able to

CO 1	Write Matrix representation for transformations.
CO 2	Find Eigen values and Eigen vector for a Matrix.
CO 3	Setup and evaluating double and triple integrals.
CO 4	Apply Green's Stokes and Gauss Divergence Theorems.
CO 5	Approximate the roots of polynomial and transcendental equations.
CO 6	Approximate the Integral value by numerical methods and solve IVP using numerical methods.

Assessment Method				
Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING FIRST YEAR: SEMESTER-II

23EC2102	**Digital Logic Design**	**PCC**	**4L: 0T: 0P**	**4 credits**

Course Learning Objective

1. To discuss the concepts of Number systems and representations used in the computers, combinational design, sequential designs and complete system design at gate-level abstraction
2. To discuss the important features of IC design like area, power and delay.
3. To design a simple digital system at gate-level as per the design specifications.

Course Content

Unit-I **(6 hours)**

Number systems-Representations-Conversions, Boolean constants and variables, basic gates: operation and truth tables, describing logic gates algebraically, evaluating logic circuit outputs, implementing circuits from Boolean expressions, universality of gates, Boolean theorems, Demorgan's theorems, alternate logic gate representations, IEEE/ANSI standard logic symbols.

Unit-II **(12 hours)**

Combinational circuit minimization using Boolean laws and Karnaugh maps, multi-level synthesis, timing hazards, logic levels and noise margins, Fan-out, Fan-in. Single bit adders and subtractors, multi-bit adders, BCD adder, multi-bit subtraction using adders, signed multiplier, unsigned multiplier, code converters, parity bit generators/checkers, magnitude comparator. Delay, Area and Power analysis in combinational circuit designs. Conversion of real-time statements into Boolean expressions and design of gate-level logic circuits.

Unit-III **(10 hours)**

Bistable elements, Latches and Flip-flops : S-R latch , S' – R' Latch, S-R latch with enable, D latch, Race-around condition and elimination methods. Edge triggered D flip flop, Edge triggered D flip flop with asynchronous inputs, master-slave flip-flop, edge triggered J-K flip-flop with asynchronous inputs, T flip-flops. Excitation tables, Characteristic equations. Flip-flop timing consideration: set-up time, hold-time discussion using positive edge-triggered D-Flip flop.

Unit-IV **(14 hours)**

Frequency division and counting. Design and analysis of asynchronous counters, Delay considerations and limitations on maximum clock frequency, Design and analysis of synchronous counters. BCD counter, Ring counter, Johnson counters. State diagram overview (Present States, Next states, Present outputs, Present inputs). Serial / Parallel data transfer registers: PIPO register, SISO register, PISO register, SIPO register.

Unit-V **(10 hours)**

Decoders: Binary decoder, synthesis of logic functions using decoders, cascading binary decoders, seven-segment decoders, applications.
Multiplexers: synthesis of logic functions using multiplexers applications.
Demultiplexers: Realization, 1-4 and 1-8 line demultiplexers, demultiplexer tree. Encoders: Priority encoders. Implementation of functions using programmable logic devices: PAL, PLA, PROM.

Unit-VI **(8 hours)**

Memory – Structure and Timing: Static RAM, Dynamic Ram. Architecture: CPLD, FPGA Design and analysis of Digital circuits: Digital Clock, Digital calendar, Traffic light controller, Mobile number sequence generators and other relevant topics

Learning Resources

Text books

1. Ronald J Tocci, Neal S.Widmer, Gregory L.Moss, *'Digital systems'*
2. Pearson 10th edition. John F.Wakerly, *'Digital Design'* , Pearson 4th edition

Reference books

1. Stephen Brown, Zvonko Vranesic, *'Fundamentals of Digital Logic with Verilog Design'*, TMH, 2nd edition.

Web Resources

1. Prof. Shankar Balachandran, NPTEL-IIT Madras, *'Digital Circuits & Systems'*
   URL: https://nptel.ac.in/courses/117106114/
2. Prof. S Srinivasan, NPTEL-IIT Madras, *'Digital Circuits and Systems'*
   URL: https://nptel.ac.in/courses/117106086/

Course Outcomes: At the end of the course, the student will be able to

CO 1	Apply the knowledge of simplification in obtaining optimal digital circuits
CO 2	Study and examine the SSI, MSI, LSI and Programmable elements
CO 3	Analyse the operation of synchronous and asynchronous state machines
CO 4	Design any combinational or sequential digital circuits to meet the given Specifications
CO 5	Analyze any digital circuit and to debug such circuit
CO 6	Prototype a real time application on EDA tool

Assessment Method

Assessment Tool	Weekly tests/Assignments (in a semester)	Monthly tests (in a semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100 %

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING SECOND YEAR: SEMESTER-I

23EC2182	**Digital Logic Design Laboratory**	**PCC**	**0L: 0T: 3P**	**1.5 credits**

Course Learning Objective

1. Expose the student to the concepts of Digital System Design and its applications
2. To understand the practical aspects of combinational and sequential circuit design
3. To design a prototype digital logic design system

List of Experiments

1. Familiarization logic gate levels understand the concept of noise- margin. Troubleshooting digital circuits.
2. Design of code converters and comparators (8-bit) on breadboard.
3. Adder related experiments: Half adder , full adder , half subtractor, full subtractor , ripple carry adder, BCD adder, carry look ahead adder using IC.
4. Design of a binary multiplier and displaying its inputs and outputs on seven segment display unit.
5. Design and verification of SR, JK, D, T latch/flip-flops. Verification and elimination of Race Around Condition.
6. Flip-flop conversions and Design of frequency dividers.
7. Design of synchronous counters (Up and Down) and displaying result on seven segment display unit
    a. Design n counter design (total 8 states design of mod 6, 7 with clear).
    b. Design and IC verification of Decade counter.
    c. Cascading of counters.
8. Synchronous counter design and displaying result on seven segment display unit
    a. Random sequence.
    b. Ring counter/Johnson counter.
9. Familiarization with multiplexer, decoder, encoder. Design of Half adder, full adder, magnitude comparator and other examples using above familiarized components.
10. Design of a mobile number sequence generator in synchronous state machine design and in asynchronous state machine design.
11. Design of a digital clock in synchronous state machine design and in asynchronous state machine design
12. Design of gate level circuit for generation of complement and sign-magnitude form of a given 4-bit signed number.
13. Design and submission of term project

Note:

1. It is mandatory to perform experiment on any one of the EDA Tools (Multisim) before the experiment is done on hardware. All experiments must be unique, design specifications should not be common in the lab

Course outcome: After the completion of this Laboratory course, the student will be able to

CO 1	Understand the practical aspects in working of discrete digital components
CO 2	Utilize the ICs of Decoder, Multiplexer, Seven segment display unit in combination circuit design
CO 3	Utilize the ICs of suitable Flip-flops in sequential circuit design
CO 4	Utilize the Programmable Logic devices in digital design
CO 5	Understand the concepts of setup time, hold time, propagation delays
CO 6	Design circuits with optimal features of Area, Power and delay
CO 7	Design and implement prototypes of complete digital systems

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ	*Term Project and Viva-Voce	End Semester Lab Exam	Total
Weightage (%)	15%	15%	30%	40%	100%

*Term Project may be hardware implementation or on EDA (Multisim) platform

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING FIRST YEAR: SEMESTER-II

23EE1281	**Computational Laboratory**	**ESC**	**0L: 0T: 3P**	**1.5 credits**

Course Learning Objective

List of Experiments

Exercise 1: Python as a tool for computation
Exercise 2: Introduction of data visualization softwares such as Power BI, Tableau, Tensorflow
Exercise 3: Introduction and familiarization with MATLAB tool
Exercise 4: MATLAB for simulink and signal processing Exercise 5: Simulations in LTSpice
Exercise 6: Simulations in MultiSim software Design and submission of lab project

Note: Any other trending softwares related to EE can be introduced.

Learning Resources Textbooks

1. J. Michael Fitzpatrick and AkosLedeczi,*' Computer Programming with MATLAB',*
2. Wordpress
3. Hanspeter langtangen, 'Python scripting for Computational Science', Springer publications Reference books
4. Misza Kalechman, *'Practical MATLAB-Basics for Engineers'*, CRC Press. Burkhard A.Meier, 'Python GUI Programming cookbook'. PACKT publications

Web Resources

1. J. Michael Fitzpatrick and AkosLedeczi, *'Introduction to Programming with MATLAB'.* URL: https://www.coursera.org/learn/matlab
2. Dr Sudarshan Iyengar, NTEL-IIT Ropar*, 'Joy of Computing using Python'*. URL: https://www.nptel.ac.in/courses/106106182/
3. https://www.mathworks.com/academia/educators.html

Course outcome After the completion of this Laboratory course, the student will be able to

CO 1	To learn the MATLAB environment, python scripting and its programming fundamentals
CO 2	Ability to write Programs using commands and functions
CO 3	Able to simulate and visualize the data of various formats
CO 4	Able to understand perform operations on applications related to different fields
CO 5	Able to perform simulation of a simple prototype design project in Electronics and communication and relevant fields

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	15%	40%
End Semester Examination weightage (%)			60%

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ENGINEERING FIRST YEAR: SEMESTER-II

23EG1281	**English-I Laboratory**	**HSC**	**0L : 1T : 3P**	**2.5 credits**

Course objectives:

1. To facilitate computer-aided multi-media instruction enabling individualized and independent language learning
2. To sensitize the students to the nuances of English speech sounds, word accent, intonation and rhythm
3. To provide opportunities for practice in using English in day to day situations
4. To improve the fluency in spoken English and neutralize mother tongue influence
5. To train students to use language appropriately for debate, group discussion and public speaking

Course Content:

UNIT-I

A recap of the grammar from the PUC Syllabus; Spoken Skills & Language in Use with Examples: Situational Dialogues – Role-play – Expressions in various situations – Self Introduction – Introducing others – Greetings – Apologies – Requests – Giving directions

UNIT-II

Theory: Energy -Alternative sources of Energy

Panel Debate on "On-grid & off-grid support to public participation in the production of solar energy in India", Reading the Wikipedia content on "The Green New Deal". Reflective session on the prospects of "The Green New Deal in India"

Writing Skills: Letter Writing (Formal & Informal) and Hands on Session on Letter Writing

UNIT-III

Theory: Transport - Problems & Solutions (Articles)

Group Discussion on "The Future of Bullet Trains in India", PPT on "The Dedicated Freight Corridors & the Future of Indian Economy"

Spoken Skills: Introduction to Speech Sounds – Vowels, Consonants and Diphthongs – Pronunciation Exercises (Basic Level) – Analogy (Verbal Reasoning)

UNIT-IV

Theory: Technology - Evaluating Technology

PPT on "3R: Reduce, Recycle, Reuse" - Solo Debate on "Can Block Chain Technology Mitigate the Issue of Cyber Crimes and Hacking?"

Presentation Skills: JAM –Description of Pictures, Photographs, Process, Talking about wishes, Information Transfer

UNIT-V:

Theory: Environment - Ecology versus Development (Common Errors)

Listening Skills: Listening Activity on YouTube video on "Greening the Deserts" - Students' seminar on

"Waste to Wealth: Examples from around the Globe".

UNIT-VI

Theory: Industry - Selling products (Agreement of the Verb with the Subject)
Reading Skills: Reading the material on "4Ps: Product, Price, Place, and Promotion" Role play on "How to sell your product and services"

Learning resources:

Text Books:

1. Non – Detailed Text Book: Panorama – A Course on Reading published by Oxford University Press, India
2. English for engineers and technologists by Orient Black Swan

Reference Books:

1. A Textbook of English Phonetics for Indian Students 2nd Ed T. Balasubramanian. (Macmillan), 2012
2. Speaking English Effectively, 2nd Edition Krishna Mohan & NP Singh, 2011. (Macmillan).
3. A Hand book for English Laboratories, E.Suresh Kumar, P.Sreehari, Foundation Books,2011
4. English Pronunciation in Use. Intermediate & Advanced, Hancock, M. 2009. CUP
5. Basics of Communication in English, Soundararaj, Francis. 2012.. *New Delhi: Macmillan*
6. English Pronouncing Dictionary, Daniel Jones Current Edition with CD.Cambridge, 17th edition, 2011.
7. A modern Approach to Verbal Reasoning – S. Chand (R.S. Aggarwal)
8. NPTEL's Course on Communication Skills

Course outcomes: At the end of the course, the student will be able to

CO 1	Understand the issues affecting the economy and environment in India and across the globe
CO 2	Develop the instinct for problem solution
CO 3	Develop the ability to collect materials on various socio-economic-technological issues and prepare PPT for presentation
CO 4	Improving listening skills
CO 5	Inculcate speaking as a behaviour by repeated practice and exposure

Assessment Method:

Course Nature: THEORY + LABORATORY

Internal Assessment (40 Marks)	**External Assessment** (60 Marks)
Record Writing – 10 Marks	Reading Comprehension – 15 Marks
Attendance – 10 Marks	Writing – 30 Marks

Continuous Assessment – 20 Marks (Listening – 10 M & Oral Presentations – 10 M)	Speaking (Viva-Voce) – 15 Marks

ENGINEERING FIRST YEAR: SEMESTER-II

23EC1201	**Electronic Devices & Circuits**	**ESC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objectives

1. To make the students understand the fundamentals of Electronic Devices and Circuits.
2. To design simple Electronic circuits understanding the concept of design specification and design requirements.

Course Content

Unit-I **(6 hours)**

Introduction

Intrinsic and Extrinsic semiconductors, Fermi Level in Intrinsic and Extrinsic semiconductors. Mobility and conductivity, Diffusion currents and drift currents, Injected minority carrier charge, contact potential, currents in forward and reverse biased junction.

Unit-II **(10 hours)**

Diodes

The open circuited p-n Junction, Current components in a p-n diode, Volt-Ampere characteristics (Forward Bias and Reverse Bias and temperature dependence of the V/I characteristic, Diode Resistance (Static and Dynamic), Diode as a circuit element ,diode models, Load line concept, Small signal analysis of diode, Transition capacitance and Diffusion capacitance, Junction diode switching times; Zener diodes, Zener breakdown and Avalanche breakdown, Zener voltage regulator and its limitations.

Unit-III **(10 hours)**

PN Diode Applications

Half Wave, Full wave and Bridge rectifiers (their operation, performance calculations), with Filters (RC, LC, RLC), Ripple factor calculations, Clippers (two level) Transfer characteristics, clampers; Diode as a switch; Diode as a analog gate, Voltage Multipliers (Doubler and Tripler).

Unit-IV **(18 hours)**

MOSFETs

MOS capacitor, MOSFET construction, Types of MOSFET (Enhancement type and Depletion type), derivation of current equation, Regions of operation, second order effects (Channel-length modulation, body effect), MOSFET characteristics and operating point including load line analysis, MOSFET as a switch (inverter). Biasing of a MOSFET.

Unit-V **(8 hours)**

BJT Characteristics

BJT construction, Transistor Junction formation (Collector-Base, Base-Emitter Junctions), Current components; Modes of Transistor operations; Early Effect, BJT input and output characteristics

indifferent configurations, BJT as an inverter.

Unit-VI **(8 hours)**

Transistor Biasing and Stabilization-BJT

Biasing techniques-different types of biasing , Transistor as an amplifier, Thermal runaway, heat sinks, Thermal stabilization, Operating point stabilization against temperature and device variations, Stability factors, Bias stabilization and compensation techniques.

Learning resources Text book

1. Jacob Milliman, Christos C. Halkias, and Satyabratajit, *'Electronic Devices and Circuits'* McGraw Hill, 3rd Edition,2012.
2. David A.Bell, *'Electronic Devices and Circuits'*, Oxford University Press, 5th edition, 2008.

Reference Books

1. Ben G.StreetMan, Sanjay Kumar Benerjee, *'Solid State Electronic Devices'*,6th edition.

Web Resources

1. Prof K Radhakrishna Rao, NPTEL-IIT Madras, *'Electronics for Analog Signal Processing-I'*. URL: https://nptel.ac.in/courses/117106087/
2. Dr. Mahesh B Patil, NPTEL-IIT Bombay, *'Basic Electronics'*. URL: https://nptel.ac.in/courses/108101091/
3. Dr. Chitralekha Mahanta,NPTEL - IIT Guwahati, *'Basic Electronics',* URL: https://nptel.ac.in/courses/117103063/

Course Outcomes : At the end of the course, the student will be able to

CO 1	Apply the knowledge of basic semiconductor physics and understand the working Principles
CO 2	Analyze the characteristics of various electronic devices like diodes, transistor etc
CO 3	Classify and analyze the various circuit configurations of transistor and MOSFETs
CO 4	Designing circuits for different applications using diodes
CO 5	Analyze the concept of stability and biasing of transistors
CO 6	Troubleshooting circuits which utilizes diodes, transistors

Assessment Method

Assessment Tool	Weekly tests/Assignments (In semester)	Monthly tests (In semester)	End Semester Test	Total

Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING FIRST YEAR: SEMESTER-II

23EC1281	**Electronic Devices & Circuits Lab**	**ESC**	**0L: 0T: 3P**	**1.5 credits**

Course Learning Objective

To get a hands-on experience on the concepts present in Basic Electronics Theory course and thereby developing practical knowledge in analysis of electronic circuits using Diodes, BJTs and MOSFETs

List of Experiments

1. Introduction to Lab Components and Electronic instruments.
2. Soldering/De-soldering of components on PCB.
3. Characteristics of PN junction Diode, Zener Diode.
4. Characteristics of LED, Photodiode.
5. Design of voltage regulators using Zener Diodes.
6. Design of Half wave Rectifier, Full wave, Bridge wave rectifier with and without LC, RC filters.
7. Design and analysis of Clippers and Clampers.
8. Design and analysis of Voltage Multipliers.
9. Design and analysis of analog gate and digital gates.
10. Transfer characteristics of MOSFETs.
11. Characteristics of Common Base, Common Emitter, Common collector configurations of BJTs.`1
12. Stability analysis and biasing of BJT Circuits.
13. Design and submission of lab project

Note: It is mandatory to perform experiment on any one of the EDA Tools before the experiment is performed on hardware. All experiments must be unique, design specifications should not be common in the lab.

Course outcome:

After the completion of this Laboratory course, the student will be able to

CO 1	Experimental verification of transfer characteristics of diodes and transistors
CO 2	Design voltage regulators using diodes
CO 3	Design multilevel clippers and clampers using diodes

CO 4	Design and troubleshooting circuits which utilizes diodes
CO 5	Experimental analysis of different configurations of transistor circuits
CO 6	Design of BJT circuits considering stability and biasing practically
CO 7	Implementing and analysing a practical prototype of Diode/BJT application

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ	*Term Project and Viva-Voce	End Semester Lab Exam	Total
Weightage (%)	15%	15%	30%	40%	100 %

*Term Project may be performed either on hardware or on any EDA tool (LT spice preferred) platform.

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING FIRST YEAR: SEMESTER-II

23EE1201	**Network Theory**	**PCC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objective

1. To make the students capable of analyzing any given electrical network
2. To equip students with network analysis tools like two port networks, Laplace transformations, and transient analysis.

Course Content

Unit- I **(10 hours)**

Basic concepts of Networks

Ohm's Laws and Kirchhoff's Laws, Open circuit and Short circuit, Current and Voltage division rule, Network Reduction Techniques – Series, Parallel, Series Parallel, Star–to-Delta or Delta-to- Star Transformations, Nodal Analysis and Mesh Analysis. Network theorem and applications. (Both Independent & Dependent sources).

Unit- II **(10 hours)**

Transient analysis of First order Circuits

Initial conditions (analysis & Problems) Natural and forced response of RL , RC Circuits, Transient analysis with different Excitations viz Step, Impulse and Sinusoidal.

Unit-III **(10 hours)**

Transient analysis of Second order Circuits

Initial conditions (analysis & Problems) Natural and forced response of RLC Circuits, Transient analysis with different Excitations viz Step and Sinusoidal.

Unit- IV **(10 hours)**

Circuit Analysis Using Laplace Transform

Introduction to Laplace transform, Circuit element models, Circuit Analysis using Laplace-examples, Transfer functions, Solution of circuit differential equations using Laplace transforms.

Unit-V **(12 hours)**

Two Port Network parameters.

Relationship of two port variables, Open circuit Impedance parameters, Short circuit Admittance parameters, Transmission Parameters, Hybrid Parameters, Relationship between parameter sets, Reciprocity and Symmetry, Interconnection of two port networks, Reciprocity Theorem.

Unit- VI **(8 hours)**

State Space Models For Electrical Networks

Concept of state, State equations, Equivalent source method, State space model and evaluation of state transition matrix, Application to electrical networks.

Learning Resources

Text Books

1. Charles K Alexander, Matthew N O Sadiku, '*Fundamentals of Electric Circuits*', Mc Graw Hill – 5th edition.
2. William H. Hayt, Jack Kemmerly, Steven M. Durbin, '*Engineering Circuit Analysis'*, Tata Mcgraw – Hill, 8th edition.

Reference Books

1. Valkenburg M.E. Van, *'Network Analysis*' , Prentice Hall.
2. N. C Jagan, CLakshmi Narayana, *'Network Theory'*, BS Publications

Web Resources

1. Prof S.C Dutta Roy NPTEL-IIT DELHI, '*Circuit Theory'*
URL: https://nptel.ac.in/courses/108102042/
2. Prof T K Basu, NPTEL-IIT Kharagpur, *'Networks, Signals and Systems*'
URL: http://nptel.ac.in/courses/108105065/

Course Outcomes: At the end of the course, the student will be able to

CO 1	Analyze the electric circuits using network theorems
CO 2	Deduce transient response for circuits
CO 3	Apply Laplace transformations for solving electric circuits problems
CO 4	Apply graph theory to obtain network theory solutions
CO 5	Analyze electric circuits using two port networks and relevant theorems
CO 6	Apply state space models for electric circuits

Assessment Method

Assessment Tool	Weekly tests/Assignments (in a semester)	Monthly tests (in a semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING FIRST YEAR: SEMESTER-II

23EE1202	**Introduction to AI/ML**	**BSC**	**2L: 0T: 0P**	**1 credits**

Course Learning

Objective

1. To understand the scope of AI and ML in real-time applications
2. To understand basics of Linear Regression, Logistic regression

Course Content

Unit-I: Introduction to AI, part-1

Concept of AI, history, current status, scope, agents, environments, Problem Formulations Unit-II: Introduction to AI, part-2

Random search, Search with closed and open list, Depth first and Breadth first search, Heuristic search.

Unit-III: Introduction to ML, part-1

Basics of Linear Regression, Logistic regression, Unit-IV: Introduction to ML, part-2

Introduction to Support Vector Machine, Principal component analysis.

Unit-V: Artificial neural networks

Multilayer Neural network, neural network and back propagation algorithm, deep neural network

Unit-VI: Python Exercises

Python exercise on neural network, PCA and random search algorithm.

Learning Resources

Textbooks

1. Peter Norvig and Stuart Russel, Artificial Intelligence- A Modern Approach (3rd edition)
2. Deepak Khemani, A First Course in Artificial Intelligence

Reference books

1. Burkhard A.Meier, 'Python GUI Programming cookbook'. PACKT publications
2. Andreas C. Müller, Sarah Guido, Introduction to Machine Learning with Python

Web Resources

1. https://in.coursera.org/specializations/machine-learning-introduction

Course outcome: After the completion of this course, the student will be able to

CO 1	Understand the scope of AI and ML in real-time applications

CO2	Understand the various available algorithms in AI and ML so as to get updated with the current technology trends

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weight age (%)	10%	30%	60%	100%

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ENGINEERING SECOND YEAR: SEMESTER-I

23MA2101	**Probability and Random variables**	**BSC**	**3L: 1T: 0P**	**3 credits**

Course objective:

1. To provide mathematical background and sufficient experience so that the student can read, write, and understand sentences in the language of probability theory, as well as solve probabilistic problems in signal processing and Communication Engineering
2. To introduce students to the basic methodology of "probabilistic thinking" and to apply it to problems.
3. To understand basic concepts of probability theory and random variables, how to deal with multiple random variables, Conditional probability and conditional expectation, joint distribution and independence, mean square estimation.
4. To understand the difference between time averages and statistical averages.
5. Understand the upper bounds and lower bounds of any probability events and given some probability generating functions.
6. Understand the Convergence of functions of random variables with different techniques

Course Contents

Unit - I **(8 Contact hours)**

Probability and theorems in probability: Probability introduction through Sets and Relative Frequency, Experiments and Sample Spaces, Discrete and Continuous Sample Spaces, Events, Probability Definitions and Axioms, Mathematical Model of Experiments, Probability as a Relative Frequency, Joint Probability, Conditional Probability, Total Probability, Baye's Theorem and Independent Events.

Unit - II **(7 Contact hours)**

Random variable and distribution: Definition of random variable, discrete and continuous random variables, independent random variables. Distribution function and its properties, Probability mass function, Probability density function and their properties. Expectation of a random variable and its properties. Variance of a random variable and its properties. Definition of bivariate random variable, discrete and continuous bivariate random variables, distribution function of a bivariate random variable , conditional probability mass function and conditional probability density function.

Unit-III **(10 Contact hours)**

Discrete distributions: Bernoulli, Binomial, Poisson, Negative Binomial, Geometric and hyper geometric distributions (Find their mean, variance and problems). Continuous distributions: Uniform, Exponential, Normal, Beta and Gamma distributions

Unit-IV **(5 Contact hours)**

Functions of random variables: Functions of one Random variable, functions of two independent random variables, Covariance, Correlation coefficient (Karl Pearson), Bi-Variate Normal Distribution.

Unit – V **(7 Contact hours)**

Generating functions: Markov's inequality, Chebyshev's inequality and CauchySchwartz's inequality (with proofs). Generating functions: Moment generating function (M.G.F) and its properties, characteristic functions (C.F) and its properties, Cummulant generating function (C.G.F) and its properties, probability generating function (P.G.F) and its properties.

Unit – VI **(8 Contact hours)**

Order statistics: Order statistics, Sequence of Random Variables, Convergence of a Sequence of Random Variables, Convergence Theorems: WLLN (weak law of large numbers), SLLN (strong law of large numbers) and Central limit theorem.

Learning resources

Text book

1. Peyton Z. Peebles,'*Probability, Random Variables & Random Signal Principles'*,TMH, 4Ed, 2001.

Reference books

1. George R. Cooper, Clave D. MC Gillem, '*Probability Methods of Signal and System Analysis',* Oxford,3 Edition,1999.
2. S.P. Eugene Xavier, '*Statistical Theory of Communication'*, New Age Publications, 1997.
3. Athanasios Papoulis and S. Unnikrishna Pillai', *Probability, Random Variables and Stochastic Processes*', TMH, 4th Ed.

Web resources

1. https://nptel.ac.in/courses/117105085/
2. https://nptel.ac.in/courses/111106112/
3. https://nptel.ac.in/courses/111102111/
4. RGUKT Course Content

COURSE OUTCOMES: At the end of the course, the student will be able to

CO 1	Apply Simple probabilities using an appropriate sample space.
CO 2	Apply Simple probabilities and expectations from probability density functions.
CO 3	Apply problem-solving techniques to solving real-world events.
CO 4	Apply selected probability distributions to solve problems.
CO 5	Apply Mean and covariance functions for simple random processes.
CO 6	Interpret and clearly present output from statistical analysis.

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING SECOND YEAR: SEMESTER-I

23EE2182	**Internet of Things Lab**	**ESC**	**0L: 0T: 3P**	**1 Credits**

Course Learning Objectives

1. To assess the vision and introduction of IoT.
2. To understand IoT Market perspective.
3. To implement Data and Knowledge Management and use of Devices in IoT Technology
4. To indulge in designing of prototype hardware for different IoT application

Course Content Exercise – I

Introduction & Overview of Internet of things

The Internet of things today and tomorrow, IoT architecture outline , Functional blocks of IOT , industrial IOT, IOT enabled Smart devices in market, Application areas for IOT, Challenges in IOT. Hardware and Software tools required for IOT application development, Overview of IOT based on Particle Hardware platforms and IDE's for development.

Exercise - II

Exploring the arduino board and its software IDE

The Arduino board, The command area, text area and message window area. Setup function, Controlling the hardware, loop functionality, verifying your sketch, uploading and running your sketch and finally modifying your sketch according to your requirement.

Exercise - III

Introduction to sensors and displays

Interfacing sensors to Arduino boards about the sensor, the circuit connections, sketch (software program), Application.And interfacing displays to arduino board

Exercise - IV Communication

Wireless communication, introduction to Bluetooth module, interfacing to Arduino in both one way communication and two way communication, controlling an LED in wireless mode, interfacing wifi module with arduino controlling things by using local network.

Exercise - V

Introduction to NodeMCU (ESP32 Wi-Fi SoC)

Controlling the things with Nodemcu using wifi communication in both ways and interfacing nodemcu with various peripheral devices. Compare Esp8266 with other arduino boards

Exercise – VI

Introduction to Cloud platforms

IOT device to cloud storage communication Model, need of Cloud services in IOT, different Cloud storage services available today, Cloud Data processing and frame format, Role of Smart phones in IOT, Examples on Home automation and Smart city development, Introduction to clouds like Temboo, Blynk, Pubnub etc.

Exercise -VII

Introduction to GSM, GPS Module

Interfacing Arduino (uno) with Gsm, Module 2G communication and interfacing GPS module for tracking location.

Exercise –VIII

Interfacing to External devices

Interfacing Arduino with External storage, Ex: SD card (reading,writing)Handling Interrupts and memory management and Ethernet communication.

Exercise –IX

Introduction to Rasberry pi

Features, Comparison with Arduino, Hardware details and Programming.

Exercise –X App Inventor

Create apps with coding, Designing apps and interfacing with Arduino.

Exercise –XI

Any one of the project from the list below Project -I

Home Automation with blue tooth and wifi and controlling the things with Mobile Apps Designing water level controller.

Project -II

Designing women safety system with GPS and GSM module Designing secured car parking system using GPS and GSM module **Project -III**

Uploading sensor information to cloud, operating and Monitoring Designing Smart Hospital with IoT devices.

Design and submission of lab project

Learning resources

Text Books:

1. Cuno Pfister, ‘Getting started with the Internet of Things: Connecting sensors and Microcontrollers to the Cloud’, O’Reilly Media Inc. Publications
2. Daniel Kellmereit, Daniel Obodovski, ‘The Silent Intelligence: The Internet of Things’, DND Ventures LLC Publications

Reference Books:

1. Pethuru Raj and Anupama C. Raman, '*The Internet of Things: Enabling Technologies, Platforms and use cases'*, CRC Press
2. Arshdeep Bahga and Vijay Madisetti, '*Internet of Things: A hands-on approach*', Universities Press

Web resources:

1. Prof Sudip Misra, NPTEL-IIT Kharagpur, *'Introduction to Internet of Things'*
   URL: https://nptel.ac.in/courses/106105166/

Course outcomes: At the end of the course, the student will

CO1	Understand and analyze concepts of Internet of Things
CO2	Familiar with arduino board and its software
CO3	Interfacing sensors with arduino board and its working
CO4	Analyze basic protocols in wireless sensor network
CO5	Understand NodeMCU arduino board for global communication
CO6	Understand cloud platform to operate our devices through controller
CO7	Design IoT applications in different domain and be able to analyze their Performance

Assessment Method:

Assessment Tool	(Internal Exam) Hardware Project submission	End Semester Lab Examination	Total
Weightage (%)	40%	60%	100%

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ENGINEERING SECOND YEAR: SEMESTER-I

23EC2101	**Analog Electronic Circuits**	**PCC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objective

To make the students understand the concept of amplifier designs using BJTs and MOSFETs and comparison between similar designs

Course content

Unit-I **(10 hours)**

MOSFET Biasing and Its Small Signal Analysis

Regions of operation of MOSFET, Biasing, Large signal and Small signal models, Channel length modulation, Design of MOSFET amplifier in Common Source, Common Gate and Common Drain configurations. Calculating small signal resistances of different MOSFET circuits.

Unit-II **(12 hours)**

Multi-Stage Amplifiers & Differential Amplifiers of MOSFET

Cascade Amplifiers, Millers theorem, and Cascode amplifiers, Frequency Analysis of Multi Stage Amplifiers, Calculation of lower & higher cutoff frequencies. Operation of Differential Amplifier, Transfer characteristics of Differential amplifier, Biasing of Differential amplifiers, MOSFET differential amplifiers using resistive loads, Calculations of Differential gain, Common mode gain and CMRR. Step response of a Differential amplifier.

Unit-III **(8 hours)**

Current mirrors in MOSFETs

Design of various configurations MOSFET (CS,CG,CD) amplifiers using current mirrors. Design of a differential amplifier with MOSFET using active load using current mirrors. Design of Single stage and two stage opamp.

Unit-IV

CMOS circuits **(12 hours)**

NMOS and PMOS inverter, NMOS inverter using active load; CMOS inverter, Pull up network and Pull down network (PUN and PDN), logic gates using CMOS, static power and dynamic power, noise margin. Pass Transistor Logic, Transmission gates. Bistability principle, Latches, Flip flops.

Unit-V **(8 hours)**

BJT- Configurations and Multi stage amplifiers

BJT - small signal analysis, Comparison between Large signal models and small signal models. and amplification and small signal resistances in different configurations (CE,CB and CC) and multi stage amplifiers.

Unit-VI **(10 hours)**

BJT- Differential amplifiers and Current mirrors

Design of various configurations BJT (CE,CB and CC) amplifiers using current mirrors. Design of a differential amplifier with BJT using active load using current mirrors. Design of Single stage and two stage opamp.

Learning Resources Textbooks

1. Behzad Razavi, '*Fundamentals of Microelectronics',*Wiley Publications
2. Sedra and Smith, *'Microelectronics Circuits',* Oxford Publications,6th Edition.

Reference Books

1. Boylestad R. L. and L. Nashelsky, *'Electronic Devices and Circuit Theory'*, 10/e or 11/e, Pearson, 2009.
2. Millman J. and C. Halkias, *'Integrated Electronics'*, 2/e, TMH, 2010.
3. Neamen D., *'Electronic Circuit Analysis and Design'*, 3/e, TMH, 2006
4. Spencer R. R. and M. S. Ghausi, *'Introduction to Electronic Circuit Design'*, Pearson, 2003

Web Resources

1. Prof.K.Radhakrishna Rao, NPTEL-IIT Madras, *'Electronics for Analog signal processing - I'*, URL: http://nptel.ac.in/courses/117106087/

Course outcomes: At the end of the course, the student will be able to

CO 1	Understand the small-signal analysis and large-signal model for BJT circuits
CO 2	Design of BJT and MOSFET amplifiers in different configurations
CO 3	Design and analyze of multi-stage amplifiers
CO 4	Design and analyze differential amplifiers with active and passive loads
CO 5	Design and analyze feedback amplifiers in different configurations
CO 6	Use these engineering abstractions to analyze and design simple electronic circuits using EDA tools

Assessment Method

Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING SECOND YEAR: SEMESTER-I

23EC2181	**Analog Electronic Circuits Laboratory**	**PCC**	**0L: 0T: 3P**	**1.5 credits**

Course Learning Objective

To make understand the concept of single stage and multistage amplifier design using BJTs and MOSFETs

List of Experiments

1. Characterization of MOSFET.
2. Design and Analysis of Single stage amplifier using MOSFETs
    a. Common Source configuration.
    b. Common Gate configuration.
    c. Common drain configuration.
3. Design and Analysis of Multi Stage Amplifier using MOSFETs
    a. Cascade Amplifier.
    b. Cascode Amplifier.
4. Design of amplifiers using Current mirrors.
5. Design and analysis of Single stage amplifier using BJTs
    a. Common Emitter Configuration.
    b. Common Collector Configuration.
    c. Common Base Configuration.
6. Differential amplifiers with passive load (Designing a specified value of CMRR).
7. Step response of a differential amplifier and designing for a rise time.
8. Single tuned amplifier design.
9. Design of Class-B power amplifier.
10. Design, build and test Public addressing system.
11. Design and submission of lab project

Note: It is mandatory to perform experiment on any one of the EDA Tools (LT spice tool) before the experiment is done on hardware. All experiments must be unique, design specifications should not be common in the lab

Course outcome

After the completion of this Laboratory course, the student will be able to

CO 1	Determine the characteristics BJT amplifiers in CE,CB,CC configurations
CO 2	Determine the characteristics of MOSFET amplifiers in CS,CG,CD Configurations
CO 3	Determine the characteristics of Cascade and Cascode amplfiers

CO 4	Designing feedback amplifiers with different configurations

CO 5	Design of differential amplifiers with active and passive loads
CO 6	Design and testing of public addressing system
CO 7	Design of a simple electronic circuit which uses multistage amplifiers

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	15%	40%
End Semester Examination weightage (%)			60%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING SECOND YEAR: SEMESTER-I

23CS2181	**Object Oriented Programming**	**ESC**	**3L: 1T: 0P**	**3 credits**

Course Learning Objectives

1. Gain knowledge about basic C++ language syntax and semantics to write C++ programs and use concepts such as variables, conditional and iterative execution methods etc.,
2. Understanding the fundamentals of object-oriented programming in C++, including defining classes, objects, invoking methods etc. and exception handling mechanisms.
3. Understand the principles of inheritance, packages and interfaces.
4. Understand the principles of Multithreading and Applet programming

Course content

Unit-1: Review of C: strings, arrays, pointers, Programming in C++ : Build and execute a C program in C++, Write equivalent programs in C++, C++ as Better C : Procedural Extensions of C

Unit-2: OOP in C++: Classes and basic Object-Oriented features (encapsulation), Overview of OOP in C++: More OO features, overloading, namespace and using struct and union

Unit-3: Inheritance : Generalization / Specialization of Object Modeling in C++, Polymorphism : Static and Dynamic Binding.

Unit-4: Type Casting &Exceptions : C++ cast operators; C++ Exceptions & standard exception

Unit-5: Classes Templates& STL - Function and Class templates and using STL like containers, algorithms.
Unit-6: File handling, streams, Interfaces and Multithreaded Programming.

References:

1. C++ Primer, Stanley Lippman, 5th edition.
2. Object-Oriented Programming with C++, E.Balagurusamy, McGraw-Hill Education (India)

Web resources:

1. PROF. PARTHA PRATIM DAS, IIT Kharagpur, NPTEL," PROGRAMMING IN C++" NPTELComputer Science and Engineering - NOC:Programming in C++
2. Object Oriented Programming in C++

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING SECOND YEAR: SEMESTER-I

23CS2182	**Object Oriented Programming Laboratory**	**ESC**	**0L: 0T: 3P**	**1 credits**

Course Learning Objective

1. To build software development skills using C++ programming for real-world applications.
2. To understand and apply the concepts of classes, packages, interfaces, array list, User defined Linked List, File Handling, exception handling and Multi-threading.

List of Experiments

Lab No 1: Basic Programs in C++.
Lab No 2: Programming Assignments on Arrays and Strings.
Lab No 3: Programming Assignments on Classes, Objects and Encapsulation.
Lab No 4: Implementing the concepts of Inheritance and Array Objects.
Lab No 5: Implementing the OOPS Concepts of Abstract, Interfaces and Polymorphism.
Lab No 6: Programming Assignments on File Handling.
Lab No 7: Programming Exercises on Exception Handling.
Lab No 8: Working with List Operations.
Lab No 9: Implementing the concepts of Multi-Threading.

Course Outcomes

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

CO 1	Understanding the control structures and conditional statements in C++
CO 2	Understanding the arrays and String handling in C++
CO 3	Understanding the difference between class and object and providing security for objects
CO 4	Understanding the reusability of objects and working with multiple objects
CO 5	Understanding about hiding the data, getting multiple inheritance through Interfaces
CO 6	Understanding the data processing from files
CO 7	Understanding about handling run time abnormal program executions
CO 8	Understanding about creating user defined linked list and dynamic objects
CO 9	Understanding the multi-threaded programming and inter thread Communication

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ/Lab Project	Total
Weightage (%)	25%	15%	40%
End Semester Examination weightage (%)			60%

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ENGINEERING SECOND YEAR: SEMESTER-I

23EC1203	**Signals and Systems**	**PCC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objectives

1. To understand the fundamental characteristics of signal and systems.
2. To understand signal and systems in terms of both the time and transform domains, taking advantage of the complementary insights and tools that these different perspective provide.
3. To develop mathematical skills to solve problems involving convolution, filtering, modulation and sampling.

Course content:

Unit - I **(10 hours)**

Mathematical representations of a signal, Common signals in Engineering: Exponential and Sinusoidal signals, singularity functions- unit impulse function, unit step function , Transformations of the independent & dependent variables, size of a signal, absolutely integrable & square integrable functions, Characterization & Classification of Signals, Modeling of systems: input-output description, typical examples of systems, Characterization, Classification and properties of systems, Interconnections of systems

Unit - II **(10 hours)**

System Response to Internal Conditions, The representation of CT signals in terms of impulses, the CT unit impulse response, system response to external input: convolution for CT LTI systems, Properties of Convolution, Properties of CT LTI systems: memoryless systems, stability, invertibility, causality; unit step response, Differential equation models & Solution of differential equations: Natural & Forced responses, ZIR & ZSR, stability in terms of natural response, System response to complex exponential inputs

Unit- III **(12 hours)**

Signals and Vectors, Signal comparison: correlation, Signal representation by orthogonal signal set, Trigonometric Fourier series, Wave Symmetry, exponential Fourier series, Convergence of the Fourier series and Gibbs Phenomenon, frequency spectra, Properties of Fourier series, Power representation using Fourier series, LTI system response to periodic inputs.

Unit- IV **(10 hours)**

Development of CTFT of an aperiodic signal, Convergence of CTFT, CTFT of some useful functions, Magnitude and Phase representation of CTFT, The CTFT of periodic signals, Properties of CTFT, Frequency spectra of signals, Signal bandwidth, System bandwidth, Frequency response of LTI systems, Energy and Power Density Spectra.

Unit-V **(12 hours)**

The Laplace Transform, Region of Convergence, Laplace transform of elementary functions,

Properties of Laplace Transform, The Inverse Laplace Transform, Response of LTI systems, System Functions, Relationship between Laplace Transform and Fourier Transform, Solution of differential and Integro-Differential Equations

Unit-VI **(6 hours)**

Periodic sampling, Sampling theorem, Pre filtering to avoid aliasing, Frequency domain representation of sampling, Reconstruction of a band limited signal from its samples, Sampling of band pass signals.

Learning Resources

Text Books

1. Alan V Oppenheim, Alan V Willsky, S. Hamid Nawab, '*Signals and Systems*', 2nd edition, Pearson/PHI, 2015
2. B P Lathi, '*Principles of Signal Processing and Linear Systems*', 1st edition, Oxford University press, 2009

Reference Books

1. Simon Haykin, Van Veen, '*Signals & Systems*', 2nd Edition, Wiley Publications, 2007.
2. Mahamood Nahvi, '*Signals and Systems*', McGraw Hill Publishers, 1st edition, 2015.

Web Resources

1. Prof. Alan V. Oppenheim, Massachusetts Institute of Technology (MIT), '*Signals and System*'. URL: https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/video-lectures/
2. Prof. K S venkatesh, NPTEL-IIT Kanpur, '*Signals and Systems*'. URL:http://nptel.ac.in/courses/117104074/
3. Prof. V.G.K. Murti, NPTEL-IIT Madras, '*Networks and Systems*'. URL: http://nptel.ac.in/courses/108106075/

Course outcomes

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

CO 1	Analyze the spectral characteristics of continuous-time periodic and aperiodic signals using Fourier analysis.
CO 2	Classify systems based on their properties and determine the response of LSI system using convolution.
CO 3	Analyze system properties based on impulse response and Fourier analysis.
CO 4	Apply the Laplace transform for analyze continuous-time and discrete-time signals and systems.

CO 5	Understand the process of sampling and the effects of under sampling.

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

ENGINEERING SECOND YEAR: SEMESTER-I

23EE2101	**Electrical Machines**	**PCC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objectives:

1. To make understand the concept of AC rotating machines.
2. To make understand the concept of the Induction motor
3. To understand the concept of synchronous generator and motor
4. To get knowledge about applications of induction and synchronous machines

Unit-I: **(10Hrs)**

DC machines: DC generators, commutation, methods of excitation, characteristics of DC generators and motors, starting and speed control of DC motors.

Unit-II: **(10Hrs)**

Transformers:Review of single-phase transformer, Polarity test, Sumpner's test, auto transformer. three phase transformers- Connections - Δ-Δ, Y-Y, Δ-Y, Y-Δ, V-V – vector groupings Yy0, Dd0, Yd1, Yd11, Dy1, Dy11, Scott connection – three winding transformer – tertiary winding.

Unit-III: **(10Hrs)**

Induction machines: construction, flux and MMF waves, equivalent circuit, speed-torque characteristics and testing- No Load and Blocked Rotor Tests, cogging and crawling, induction generators.

Unit-IV: **(10Hrs)**

Starting Methods and Starting Current and Torque Calculations Speed Control-Change of Frequency; Pole Changing and Methods of Consequent Poles; Cascade Connection. Single Phase Induction Motors: Single phase induction motor – Constructional features - Double revolving field theory – Elementary idea of cross-field theory – split-phase motors – starting methods of single-phase induction motors.

Unit-V: **(10 Hrs)**

Synchronous machines: basic synchronous machine model, synchronous reactance, armature reaction, synchronizing to infinite bus bars, operating characteristics, power flow equations.

Unit-VI: **(10 Hrs)**

Salient pole machines, parallel operation, hunting, synchronous motors, V and inverted V curves, starting of synchronous motors. The theoretical concepts will be supplemented using numerical examples.

Learning Resources:

Text Books:

1. I J Nagrath and D P Kothari, “Electric Machines”, McGraw Hill Education, Third Edition, 2004.
2. P S Bimbhra, “Electrical Machinery” Khanna Publishers, Seventh Edition, 2011.

Reference Books:

1. M G Say, “Performance and design of AC machines”, CBS Publishers, Third Edition, 2002.
2. A E Fitzgerald and C Kingsley, "Electric Machinery”, McGraw Hill Education, Seventh Edition, 2020.
3. J B Gupta “Theory and performance of Electrical Machines”, S.K.Kataria & Sons Publishers 14th Edition, 2009.

Web resources:

1. Prof. P. Sasidhara Rao, NPTEL, IIT-Madras, Electrical Machines-II https://nptel.ac.in/courses/108/106/108106072/
2. Prof. Tapas Kumar Bhattacharya NPTEL, IIT-Khragpur, Electrical Machines-II, https://nptel.ac.in/courses/108/105/108105131/

Course Outcomes:

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

CO 1	Understand Induction motor operation, construction, and applications
CO 2	Understand the starting and speed control techniques for induction motors
CO 3	Understand Synchronous generator operation, construction, and applications
CO 4	Analyze the parallel operation of alternators
CO 5	Understand the principle of operation of Synchronous motor
CO 6	Understand the applications and starting methods of Synchronous motor

ENGINEERING SECOND YEAR: SEMESTER-I

23EE2181	**Electrical Machines Lab**	**PCC**	**0L: 0T: 3P**	**1.5 credits**

Course Learning Objectives:

1. To make understand the concept of Induction motors in real-time
2. To make understand the concept of the speed control of the Induction motor
3. To understand the concept of voltage regulation of Alternator in real-time
4. To get knowledge about the operation of Synchronous and induction machines
5. To get familiar with AC electrical Machines

List of Experiments:

1. Torque-speed characteristics of squirrel cage Induction Motor
2. Speed Control of wound rotor Induction motor using rotor resistance control
3. Parameter estimation of squirrel cage Induction motor using Blocked rotor & No-load test
4. Determination of voltage regulation of Synchronous generators using EMF & MMF method.
5. V and inverted V curves of Synchronous motor.
6. V and inverted V curves of synchronous generators.
7. Speed Control of Induction motor using rotor using V/f control method
8. Determination of voltage regulation of Synchronous generators using ASA method.
9. Equivalent circuit diagram of 1-phase Induction motor
10. Parallel operation of Alternators
11. Sumpner's test on two single phase transformers
12. Scott connection of single phase transformers
13. Determination of OCC & Load characteristics of D.C. generators
14. Swinburne's Test on DC Machine
15. Brake test on D.C. Shunt motor
16. Design and submission of lab project

Note: Instructors should cover at least 9 experiments from the above list. Apart from this, instructors can choose more experiments if time permits.

Course Outcomes At the end of the course: The student will be able to

CO 1	Analyze Torque-speed characteristics of induction motor
CO 2	Analyze no-load, blocked rotor, and speed control of induction motor
CO 3	Analyze the voltage regulation of Alternators
CO 4	Analyze the Parallel operation of Alternators
CO 5	Understand the principle of operation of AC machines
CO 6	Understand the Phasor and equivalent circuit diagrams of induction motor and

	Alternators

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ/Lab Project	Total
Weightage (%)	25%	15%	40%
End Semester Examination weightage (%)			60%

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ENGINEERING SECOND YEAR: SEMESTER-II

23EE2281	**Robotics Laboratory**	**ESC**	**0L: 0T: 3P**	**1 credits**

Course Learning Objectives:

1. To differentiate different types of robots.
2. To analyze the components of robots, sensors, actuators.
3. To be exposed to coordinate transformations, I/O logic, wireless and wired communication.
4. To explore the applications of Arduino and Raspberry pi for Robotics
5. To get familiarization with aerial robotics: Drones

Course Content:

Exercise- I
Introduction to Robotics
What is robot and robotics, already designed robots, Manual and Autonomous robots, Different types of industrial arm robots, and arm design, Coordinate transformations for more motor moments, Electrical connections of different boards and modules: How to connect closed circuit, digital and analog pins connections.

Exercise-II
Logic design, Actuators and sensors
Logic and binary math conversions: OR, AND, XOR, XNOR gates, binary and hexadecimal conversions, Introduction to Arduino, Actuators, Sensors, Wired and wireless communication, I/O communication through USB cable, Bluetooth HC05, RF modules, DTMF module, Xbee modules.

Exercise-III
Basic robots and Raspberry Pi
Line follower: Line follower robot design and control with Arduino board, Obstacles avoider: Obstacle avoider robot with IR sensors and Arduino board, Mobile controller: Mobile controller robot with DTMF module and HC05 module, Introduction to Raspberry pi: What is raspberry and differences between Arduino and raspberry pi, Applications of robotics.

Exercise – IV
Introduction to Aerial robots and Drones

List of Experiments:

1. Introduction to Robotics: Study of different parts of a robot.
2. Study of various aspects with respect to on-board sensors, actuators, drivers and other peripherals.
3. Familiarization with 8051, 8052 micro-controller board.
4. Familiarization with Arduino Boards along with Actuator Testing.
5. Building Line Follower Robot.
6. Enhanced Line Follower Robot design using state machines and coding for state machines.
7. Introduction to Bluetooth, Wi-Fi module, DTMF and building a Mobile Controller Robot.
8. Introduction to Raspberry Pi.
9. Usage of GPIO and Raspberry Pi Camera Module on Raspberry Pi board.
10. Colour Detection and Segmentation and building colour tracking Robot.
11. Introduction to Aerial Robots (Drones, UAV etc.)
12. Introduction to Pixhawk Auto-Pilot.
13. Calibration of Drone and Flight Test.
14. Team Project.

Text Books:

1. John J. Craig, *'Introduction to Robotics: Mechanics and Control'*, Pearson Publications, 2005.
2. Siegwart R and Nour bakhsh I.R, *'Introduction to Autonomous Mobile Robots'*, Prentice Hall India, 2005.

Reference Books:

1. Murphy Robin R, *'Introduction to AI Robotics'*, MIT Press, 2000.
2. MykePredko, "Programming Robot Controllers" – McGraw-Hill, 1st edition, 2003.

Video Reference:

1. Prof. Khatib, Stanford University, 'Introduction to Robotics' URL:https://see.stanford.edu/Course/CS233A

Course Outcomes:

CO1	Learners will be able to differentiate different types of robots.
CO2	Learners will be able to analyse the components of robots, sensors, actuators.
CO3	Learners will be able to explain the coordinate transformations, I/O logic, wireless and wired communication
CO4	Learners will be able to analyse the Arduino and Raspberry pi usage in robotics
CO5	Learners will be able to design and control basic two-wheel robot model

Assessment Method:

Assessment Tool	(Internal Exam) Hardware Project submission	End Semester Lab Examination	Total
Weightage (%)	40%	60%	100 %

ENGINEERING SECOND YEAR: SEMESTER-II

23EE2201	**Power Systems-I**	**PCC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objectives

1. To understand the different types of Conventional power generating stations.
2. To understand different Non-Conventional Energy sources
3. To understand and concepts of the economics of generation
4. To evaluate the transmission line parameters calculations
5. To understand the performance of different types of Transmission lines.
6. To understand the concept of underground cables and distribution systems

UNIT-I Conventional power generation (08 hours)

Structure of power system: Generation, Transmission and distribution systems; Conventional sources of electric energy, Thermal, Gas power plant model, power generation, hydropower generation, Nuclear power generation.

UNIT-II Non conventional power generation (10 hours)

Non-conventional sources of electric energy, Wind energy conversion: introduction, types of wind turbines, wind generation and control. Solar energy: Solar photovoltaic cells and generation. Block diagram models of wind and solar energy generation systems.

UNIT-III Economics of power generation (10 hours)

Definitions of connected load, maximum demand, demand factor, load factor, diversity factor, and load duration curve. Baseload and peak load plants, tariff. Problems on different factors.

UNIT-IV Transmission line parameters (12 hours)

Transmission line parameters: Types of conductors, calculation of resistance of solid conductors and effect of resistance on solid conductors, calculation of inductance for single-phase and three-phase, single and double circuit lines, the concept of GMR, GMD, symmetrical and asymmetrical conductor configuration with and without transposition, Skin and Proximity effect, corona; Calculation of capacitance for 2 wire and 3 wire systems, the effect of ground on capacitance, capacitance calculations for symmetrical and asymmetrical single and three- phase, single and double circuit lines.

UNIT-V Performance of Transmission lines (12 hours)

Performance of short and medium-length transmission lines: Classification of transmission lines, short, medium, and long line and their model representations, nominal-T, nominal-Pie, and A, B, C, D constants for symmetrical and asymmetrical networks, mathematical solutions to estimate regulation and efficiency of all types of lines, Performance of long transmission lines: Long transmission line, rigorous solution, evaluation of A, B, C, D constants, representation of long lines, equivalent-T and equivalent Pie network models; Ferranti effect, charging current, effect on the

regulation of the transmission line, surge impedance and SIL of long lines, wavelength and velocity of propagation of waves.

UNIT-VI

Under Ground Cables, EHV and HVDC Transmission (8 hours)

Underground cables: Types of cables, construction, types of insulating materials, calculation of insulation resistance and stress in insulation, the capacitance of single and 3core belted cables, grading of cables, capacitance grading, numerical problems, description of inter-sheath grading, HV cables. Need of EHV transmission systems, types of DC links, comparison of AC and DC transmission, the advantage of DC transmission, HVDC systems in India.

Learning Resources:

Text Books:

1. C L Wadhwa, “Electric Power Systems”, New age publications, New Delhi, 9th Edition, 2007. Singh S N, “Electric Power Generation, Transmission and Distribution”, Prentice Hall of India Pvt. Ltd., New Delhi, 2nd Edition, 2002.
2. Solanki, “Renewable Energy Technologies: Practical Guide for Beginners”, PHI Learning Pvt. Ltd., 2008

Reference books:

1. M.V. Deshpande –Elements of Electrical Power Station Design, Third Edition, Wheeler Pub. 1998 H.Cotton& H. Barber-The Transmission and Distribution of Electrical Energy, Third Edition, Hodder Arnold;
2. V.K Mehta and Rohit Mehta, “Principles of Power Systems”, S. Chand& Company Ltd, New Delhi, 2004.
3. D.Mukherjee: Fundamentals Of Renewable Energy Systems, New Age International publishers, 2007 Gilbert M. Masters: Renewable and Efficient Electric Power Systems, John Wiley & Sons, 2004.

Web resources:

1. Prof. D.P. Kothari, NPTEL-IIT Delhi, *‘Power System Generation, Transmission and Distribution (Encapsulated from earlier Video)* URL: https://nptel.ac.in/courses/108/102/108102047/

Course Outcomes At the end of the course the student will be able to

CO 1	Understand the concepts of power systems.
CO 2	Understand the operation of conventional generating stations and renewable sources of electrical power.
CO 3	Determine the electrical circuit parameters of transmission lines

CO4	Understanding the performance of transmission lines
CO 5	Understand the underground cables and High Voltage transmission
CO 6	Understand the basics of Distribution systems

Assessment Criteria:

Assessment Tool	(Internal Exam) Hardware Project submission	End Semester Lab Examination	Total
Weightage (%)	40%	60%	100%

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING SECOND YEAR: SEMESTER-II

23EE2204	**Machine Learning**	**PCC**	**3L: 1T: 0P**	**3 credits**

Course Learning Objectives

1. To provide a broad survey of approaches and techniques in machine learning.
2. To develop a deeper understanding of several major topics in machine learning.
3. To develop the basic skills necessary to pursue research in machine learning.

Course Content

Unit- I **(6 hours)**

Introduction, Different types of Learning, Hypothesis space and Cross-Validation, Linear Regression, Introduction to decision trees, learning decision trees, over fitting, Python exercise on decision trees and linear regression

Unit- II **(7 hours)**

K-Nearest neighbour, feature selection, feature extraction, collaborative filtering, python exercise on Knn and PCA.

Unit- III **(8 hours)**

Bayesian Learning, Naïve Bayes, Bayesian Network, Python exercise on Naïve Bayes

Unit- IV **(8 hours)**

Logistic regression, Introduction to Support Vector Machine, SVM: The Dual formation, SVM: maximum margin with noise, nonlinear SVM and Kennel function, SVM: solutions to the dual problem, Python exercise on SVM.

Unit- V **(8 hours)**

Multilayer Neural network, neural network and back propagation algorithm, deep neural network, python exercise on neural network.

Unit- VI **(8 hours)**

Introduction to computational learning theory, sample complexity: finite hypothesis space, VC Dimension, Introduction to Ensembles, Bagging and Boosting, Clustering, means clustering, agglomerative hierarchical clustering, python exercise on clustering.

Learning Resources:

Text Books

1. Tom Mitchell, '*Machine Learning*', McGraw- Hill, 1997, 1st Edition.
2. EthemAlpaydin, '*Introduction to Machine Learning*', Phi, 2nd Edition.

Web resources

1. Prof Sudeshna sarkar, NPTEL- IIT Kharagpur, '*Introduction To Machine Learning'*. URL: http://nptel.ac.in/courses/106105152/

Course Outcomes: At the end of the course, the student will be able to

1	Understand the fundamental issues and challenges of machine learning like data, model selection, and model complexity.
2	Understand strengths and weaknesses of many popular machine learning approaches.
3	Design and implement various machine learning algorithms in a range of real world applications.

Assessment Method:

Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING SECOND YEAR: SEMESTER-II

23EE2202	**Control Systems**	**PCC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objective

1. To explore the modeling of linear dynamic systems via differential equations and transfer functions utilizing state- pace and input-output representations.
2. Analysis of control systems in the time and frequency domains and using transfer function and state-space methods.
3. Study of the classical stability tests, such as the Routh-Hurwitz and Nyquist criterions, and design methods using root-locus plots and Bode plots.

Course content

Unit – I **(6 hours)**

Introduction-Open loop and closed loop control systems- Transfer functions- Block diagrams and their reduction - Signal flow graphs - Mason's gain formula.

Unit – II **(6 hours)**

Mathematical modeling and transfer functions of electrical circuits and mechanical systems. Principle and operation of Servo motors and Stepper motors.

Unit – III **(8 hours)**

Standard test signals, step response of first and second order systems – Time response specifications – steady state error – static error and generalized error coefficients – response with proportional, derivative and integral controllers.

Unit – IV **(8 hours)**

Concept – characteristic equation – location of roots in the s-plane for stability – Routh-Hurwitz criterion –– Root locus – rules for the construction of root locus- construction of root locus diagram.

Unit – V **(8 hours)**

Introduction -Bode plots – Gain margin and Phase margin - Polar plots - Nyquist stability criterion – Need for compensators - Lag and lead compensators in frequency domain.

Unit-VI **(9 hours)**

Concepts of state, state variables and state model, derivation of State models from block diagrams, Diagonalization ,Solving the Time invariant state Equation, state transition Matrix and it' s Properties, Concepts of Controllability and Observability.

Learning Resources

Text Books

1. B.C.Kuo, *'Automatic Control systems'*, John Wiley and Sons, 8th edition,2003.
2. K.Ogata, *'Modern Control Engineering'*, Prentice Hall of India Pvt. Ltd., 5th edition, 2010.

References

1. I.J.Nagrath and M.Gopal, *'Control system Engg'*, New Age International (P) Limited Publishers,5thedition, 2007.
2. Norman S. Nise, *'Control system engineering'*, Wiley India, 5th edition 2000.

Web resources:

1. Prof. MadanGopal, NPTEL- IIT Delhi, '*Control Engineering',* URL: http://nptel.ac.in/courses/108102043/
2. Prof. S.D. Agashe, NPTEL-IIT Bombay, '*Control Engineering*', URL: http://nptel.ac.in/courses/108101037/
3. Prof. MadanGopal, NPTEL-IIT Delhi, '*Control Engineering*', URL: http://nptel.ac.in/courses/108102044/

Course outcomes: At the end of the course, the students will be able to

CO 1	Analyze controllability and observability of linear systems.
CO 2	Design state-space controller and appropriate (deterministic) observer.
CO 3	Design controller with frequency design methods.
CO 4	Apply root-locus method for analysis and synthesis.
CO 5	Apply pole placement controller design approach.
CO 6	Design linear quadratic regulator for discrete-time systems.

Assessment Method

Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING SECOND YEAR: SEMESTER-II

23EE2282	**Control Systems Lab**	**PCC**	**0L: 0T: 3P**	**1.5 credits**

Course learning objective:

The objective of the lab is to design a system and calculate the transfer function, analyzing the stability of the system (both open and closed loop, with positive and negative feedback) with time domain approach and frequency response analysis, using MATLAB and also developing the system which is dynamic in nature with state space analysis approach.

List of Experiments:

1. Time response of Second Order systems using MATLAB
2. Characteristics of Synchros
3. Programmable Logic Controller-Study and verification of truth tables of logic gates, simple Boolean expressions and application of speed control of motor
4. Effect of feedback on DC servo motor
5. Transfer function of DC motor
6. Effect of P, PD, PI, PID Controller on second order systems.
7. Lag and Lead compensation - Magnitude and phase plot
8. Position control of DC motor.
9. Temperature controller using PID
10. Characteristics of AC Servo motor.
11. PSPICE simulation of of P, PD, PI, PID Controller using Op-Amp for second order systems
12. Stability analysis (Bode, Root Locus, Nyquist) of Linear Time Invariant systems using MATLAB.
13. State space model for classical transfer function using MATLAB

Course outcomes: At the end of the course, the students will be able to

CO1	Recognize the symbols for the different parts of a block diagram: functional blocks, summing blocks and branch points
CO2	Model a mechanical (masses, dampers and springs) and electrical system (inductors, resistors, capacitors) in the form of a transfer function
CO3	Determine the impulse, step, and ramp response of a system, given a transfer function model
CO4	Perform Routh's stability criterion and root locus of a system to determine Stability
CO5	For systems with unknown values, determine the range of values for which the system will be stable and explain how adding a pole or a zero affects the stability

CO6	Analyze feedback control systems in the time and frequency domain to use state space concepts to describe systems
CO7	Recognize the “type” of a system (based on the number of free integrators) and discuss the expected error characteristics as related to step, ramp, and acceleration Inputs
CO8	Interpret design criteria as related to the closed loop pole location on the complex Plane
CO9	Draw the Frequency response plots like Bode, Nyquist and Polar plots (magnitude and phase) for a given transfer function
CO10	Design feedback compensators to achieve a set of desired closed loop system characteristics and design a compensator in the frequency domain to meet specific design requirements using a lead compensator, lag compensator, or lead-lag Compensator

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	15%	40%
End Semester Examination weightage (%)			60%

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING SECOND YEAR: SEMESTER-II

23EC2203	**Linear Integrated Circuits**	**PCC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objectives

1. To study the basic principles, configurations and practical limitations of op-amp.
2. To understand the various linear and non-linear applications of op-amp
3. To analyze and deign op-amp oscillators, single chip oscillators and frequency generators
4. To understand the operation of the most commonly used D/A and A/D converter types and its applications

Course content:

Unit-I **(10 hours)**

Feedback Amplifiers

Feedback concept, General characteristics of Negative feedback amplifier, Different feedback amplifiers (Voltge-series feedback, Current-series feedback, Current-shunt feedback, Voltage-shunt feedback), Effect of negative feedback on input and output impedances, gain & bandwidth

Unit-II **(10 hours)**

Operational Amplifiers

Ideal op-amp parameters, non-ideal op-amp, opamp in negative feedback, bandwidth and slew rate on circuit Performance. Op-amp applications- summing amplifier, integrator, differentiator, Instrumentation amplifier, V to I and I to V converter, comparator, precision Rectifier, log and antilog amplifier. Active filters.

Unit-III **(12 hours)**

Wave shaping circuits & Oscillators

Postive feedback concept, Barkhausen criterion and design of RC phase oscillators, Wien Bridge oscillator. Ring oscillator, LC oscillators and crystal oscillators, Multivibrators – Astable, Monostable and Bistable Multivibrators, Schmitt trigger, square and triangular waveform generators.

Unit-IV **(8 hours)**

DC-DC Converters

Introduction, Performance parameters of DC-DC converters, Frequency limiting parameters, Types of converters: Buck, boost and buck-boost.

Unit-V **(10 hours)**

PLL

Basic PLL topology and principle, Major building blocks of PLL- analog and digital phase detector,VCO, applications of PLL.

Unit-VI **(10 hours)**

Data Converters

Analog vs discrete time signals, Sample-and-Hold circuits, ADC architectures (Flash ADC, Successive Approximation ADC, Dual slope ADC. DACs(Binary weighted resistors, R-2R DAC and current steering DAC). INL & DNL

Learning Resources

Textbooks

1. Behzad Razavi, '*Fundamentals of Microelectronics',*Wiley Publications
2. Sedra and Smith, *'Microelectronics Circuits',* Oxford Publications,6th Edition.
3. R Jacob Baker, 'CMOS Mixed Signal Circuit Design', Wiley Publications

Reference Books

1. Boylestad R. L. and L. Nashelsky, *'Electronic Devices and Circuit Theory'*, 10/e or 11/e, Pearson, 2009.
2. Millman J. and C. Halkias, *'Integrated Electronics'*, 2/e, TMH, 2010. Neamen D., *'Electronic Circuit Analysis and Design'*, 3/e, TMH, 2006
3. Spencer R. R. and M. S. Ghausi, *'Introduction to Electronic Circuit Design'*, Pearson, 2003

Web Resources

1. Prof D Nagendra Krishnapura, NPTEL-IIT Madras, *'Analog Integrated Circuit Design'* URL: https://nptel.ac.in/courses/117106030/
2. Prof K Radhakrishna Rao, NPTEL-IIT Madras, *'Electronics for Analog Processing-II'*, URL: https://nptel.ac.in/courses/117106088/

Course outcomes: At the end of the course, the students will be able to

CO1	Infer the DC and AC characteristics of operational amplifiers and its effect on output and their compensation techniques.
CO2	Elucidate and design the linear and nonlinear applications of an op-amp and special application ICs.
CO3	Explain and compare the working of multi vibrators using special application IC 555 and general purpose op-amp.
CO4	Classify and comprehend the working principle of data converters.
CO5	Illustrate the function of application specific ICs such as Voltage regulators, PLL and its application in communication.

Assessment Method

Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

ENGINEERING SECOND YEAR: SEMESTER-II

23EC2283	**Linear Integrated Circuits Laboratory**	**PCC**	**0L: 0T: 3P**	**1.5 credits**

Course Learning Objective

1. Experimentally demonstrate the frequency response of amplifiers
2. Practical knowledge on different types of multivibrators and their applications
3. Introductory designs on Analog to Digital Converters
4. Practical exposure to CMOS circuit design especially operational amplifiers
5. Familiarization with CAD tool for analog circuit design

List of Experiments

1. Design and analysis of Feedback amplifiers.
2. Frequency response of inverting & non-inverting amplifier.
3. Design of an Instrumentation amplifier.
4. Schmitt trigger & Noise suppression using Bistable multivibrator.
5. Monostable & Astable multivibrator using opamp.
6. Design of amplifier using CMOS inverters.
7. Two – bit flash ADC design.
8. Design of a typical CMOS inverter(sizing) using EDA tool and finding transfer characteristics & finding the propagation delay.
9. Design of a two input CMOS NAND & NOR gates (sizing) using EDAtool.
10. Design of a fully differential single stage opamp using resistive loads using EDA tool
11. Design of a single stage opamp using diode connected load using EDA tool
12. Term Project(Designing Public Addressing System).

*EDA tool may be Mentor Graphics/Synopsys/Cadence tools

Note: It is mandatory to perform experiments (1-7) on LTspice tool before the experiment is done on hardware. All experiments must be unique, design specifications should not be common in the lab.

Course outcome:

After the completion of this Laboratory course, the student will be able to

CO 1	To analyze the frequency response of amplifiers
CO 2	Experimentally know the noise suppression in bistable multivibrators
CO 3	Utilization of IC 555 timer
CO 5	Design of Analog to Digital Converters
CO 6	Design of CMOS circuits using CAD tool
CO 7	Design of operational amplifiers
CO 8	Design of a prototype project using the concepts of analog electronic circuits

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	15%	40%
End Semester Examination weightage (%)			60%

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING SECOND YEAR: SEMESTER-II

23EE2203	**Power Electronics**	**PCC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objectives:

1. To introduce the concept of semiconductors devices for high power supply and their applications.
2. To understand the need for Power Electronics Devices and Circuits and their basic operation.

Course content

Unit-I: Introduction **(10 hours)**

Introduction to Power Electronics, Power Semiconductor Devices: Power Diodes, power Transistors, power MOSFETs, IGBTs, GTOs, Thyristors, Basic theory of operation, characteristics, Ratings, Protection and cooling, line commutation and forced commutation circuits.

Unit II: Converters **(10 hours)**

Power Electronic converters: 1-phase / 3 phase rectifier circuits, 1-phase / 3 phase phase-controlled converters (Semi-converters, full–converters and Dual converters) using IGBT Analysis and performance with passive and active load, Harmonics and power factor, Introduction to power quality.

Unit III: D.C converters **(6 hours)**

D.C-to-D.C converters (choppers): Buck, Boost and Buck-Boost type and various chopper configurations.

Unit IV: A.C converters **(8 hours)**

A.C-to-A.C converters: A.C voltage controllers, Cyclo-converters, Introduction to matrix converters

Unit V: Inverters **(10 hours)**

D.C–to-A.C converters (Inverters): 1-phase VSI in half bridge and full bridge configuration, CSI, Frequency and voltage control, Line-commutated inverters (LCIs).

Unit-VI: APPLICATIONS **(8 hours)**

Power system applications- Static AC circuit breaker, interconnection of renewable energy sources and energy storage systems to the utility, Industrial applications -Switch mode welder, Voltage source series resonant inverters in induction heating, solid state relay. Applications for DC-DC converters, fully integrated voltage regulators.

Learning Resources

Text Books

1. Daniel W Hart, *Power Electronics* Tata Mc Graw Hill
2. Issah Batterseh, *Power Electronic Circuits*, Wiley.
3. N. Mohan, T.M. Undeland & W.P. Robbins, *Power Electronics: Converter, Applications & Design*, John Wiley & Sons, 1989
4. Muhammad H. Rashid, *Power Electronics: Circuits, Devices, and Applications*, Pearson, 2009

Reference Books

1. Bimal K Bose, *Modern Power Electronics and AC motor Drives*, Pearson Publishers.
2. Joe H. Chow, Alex M. Stankovic, David J. Hill, *Power Electronics and Power Systems* Springer Publications.

Web Resources:

1. Prof. G. Bhuvaneshwari, NPTEL-IIT-Delhi, Power Electronics.
URL:https://archive.nptel.ac.in/courses/108/102/108102145/

Course outcomes: At the end of the course, the students will be able to

CO1	Understand the need for Power Electronics Devices and Circuits and their basic operation.
CO2	Perform an analysis of driving and control and triggering circuits for Power Electronic Converters
CO3	Perform an analysis of AC to DC converters (Single phase and three phase, controlled and uncontrolled), A.C Voltage controllers, DC to DC converters(choppers), and single phase D.C to A.C converters (Inverters) in square wave mode.
CO4	Perform Fourier analysis and knowledge of Power Quality issues associated with power electronic circuits.
CO5	Understand different applications of power electronics.

Assessment Method

Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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ENGINEERING SECOND YEAR: SEMESTER-II

23EE2283	**Power Electronics Lab**	**PCC**	**0L: 0T: 3P**	**1.5 credits**

Course Learning Objective:

The course is introduced to the students to enable laboratory scale practical knowledge about power system operation and performance analysis of both hardware and software.

List of Experiments:

1 To study the characteristics of Silicon Controlled Rectifier (SCR) and to find its holding and latching current
2 To study the switching characteristics of IGBT.
3 To study the switching characteristics of FET.
4 To study the full wave bridge rectifier circuit and understand its effects on power quality
5 To study single phase inverter with different loading conditions.
6 To study three phase inverter with different loading conditions
7 To study Sinusoidal Pulse Width Modulation
8 To study high frequency switching
9 To study the performance of DC-DC buck converter circuit at different duty ratios
10 To study the performance of single phase full bridge inverter circuit operating in square wave mode using IGBT
11 To study the performance of DC-DC boost converter circuit at different duty ratios

Course Outcomes: Upon successful completion of the course, student should be able to

CO1	Understand the basic concepts of device characteristics and triggering Techniques
CO2	Understand the operation of different type of rectifier/converter circuits with different loads
CO3	Understand the operation of choppers, AC voltage controllers and Inverters

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	15%	40%
End Semester Examination weightage (%)			60%

ENGINEERING THIRD YEAR: SEMESTER-I

23EC2103	**Digital Signal Processing**	**PCC**	**3L: 1T: 0 P**	**3 credits**

Course Learning Objectives:

1. To understand the mathematical approach to manipulate discrete time signals, which are useful to learn digital telecommunication
2. To study the transformations on digital signals.
3. To understand the concepts of digital filters

Course Contents:

UNIT- 1 Introduction **(10 hours)**

A basic review of Signals and Systems, Basic elements of digital signal processing, Time domain representation of discrete time signals, Basic Operations on sequences including Sampling rate alteration, Classification of sequences. Discrete time systems, Time domain characterization of LTI DTS: Convolution sum, Impulse & Step Responses, Simple Interconnection schemes, Linear Constant Coefficient Difference Equations (of Finite- dimensional LTI DTS), Classification of LTI DTS: FIR & IIR, Recursive, & Non- recursive.

UNIT-II Discrete Time Fourier Transform (DTFT) **(10 hours)**

Introduction, Fourier Transform Representation of aperiodic Discrete-Time Signals, Periodicity-convergence of DTFT, Properties of DTFT, Signal Transmission Through LTISystems,Ideal and Practical Filters, energy spectral Density, Power spectral Density.

UNIT - III Discrete Fourier Transform (DFT) **(12 hours)**

Sampling of DTFT, Discrete Fourier Transform(DFT) and its Inverse, DFT as a Linear Transformation, Properties of DFT, Linear Convolution Using the DFT, Filtering of Long Data Sequences Using DFT, Spectrum analysis Using DFT. Fast Fourier Transform(FFT) Introduction ,Computational Complexity of the Direct Computation of the DFT , Decimation- In-Time (DIT) FFT Algorithm, Decimation-in-Frequency (DIF) FFT Algorithm and their comparison, Inverse DFT using FFT Algorithm, A Linear Filtering. Approach to Computation of the DFT-The GoertzelAlgorithm ,The Chirp-z Transform Algorithm.

UNIT- IV Z transforms **(10 hours)**

Introduction ,Bilateral (Two-sided) Z-transform , Relationship Between Z-transform and DTFT,Z-Plane, Region-of-Convergence for Z-transforms and their properties, properties of Z-transform, Z-Transform of Causal Periodic Signals, Inversion of the Z-transform, Analysis and Characterization of LTI Systems using the Z-transform. The Unilateral (One-Sided) Z-transform,

Properties of unilateral Z-Transform. Transient Response and Steady-State Response Block Diagrams Representation. Applications of Z- Transform in Signal Processing

UNIT - V Filter Concepts (8 hours)

Introduction, Frequency Response and Filter Characteristics, Zero-Phase Filter, Linear phase Filter, simple FIR and IIR Digital Filter, All pass Filters, Minimum-Phase, Maximum-Phase and Non-minimum (Mixed) Phase Systems, averaging filter, comb filter, Notch filter.

UNIT-VI Realization Of Digital Filters (10 hours)

Introduction, FIR Filter, IIR Filter, Non-recursive and Recursive Structures, FIR Filter Structures, Basic Structures for IIR Systems , Lattice Structures for FIR and IIR systems.

Learning Resources:

Textbooks:

1. A.V.Oppenheim and R.W. Schaffer, *Discrete Time Signal Processing* , 3rd edition, Pearson Education/PHI,2014.
2. John G. Proakis,Dimitris G.Manolakis,*Digital Signal Processing, Principle Algorithms, and Applications* , 4th edition, Pearson Education / PHI,2007

Reference books:

1. Sanjit K Mitra, *Digital signal processing: A computer base approach* ,4thedition, Tata McGraw Hill,2013
2. B.P.Lathi, Roger Green, Essentials of Digital Signal Processing, Cambridge university press.

Course outcomes: At the end of the course, the student will be able to

CO 1	Interpret ,represent and process discrete/digital signals and systems
CO 2	Understand the spectral analysis of signals
CO 3	Design &analyze DSP systems like FIR and IIR Filter etc
CO 4	Familiarize with multirate signal processing
CO5	Familiarize with applications of Digital Signal Processing

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING THIRD YEAR: SEMESTER-I

23EE3101	**Power Systems-II**	**PCC**	**3L: 1T: 0 P**	**4 credits**

Course Learning Objectives:

1. Interpret the entries of bus impedance and admittance matrices using the singular transformation method, step by step method to obtain primary data of load flow analysis.
2. Build the algorithms to form the bus impedance and admittance matrices for various configurations of primitive networks.
3. Outline the conditions of a power system to undergo steady-state, dynamic, or transient stabilities studies.

Course Contents:

UNIT- 1 Per Unit System of Representation and Power System Network Matrices (10 hours)
Per Unit system of Representation: Necessity, Advantages, Applications in Power Systems and Calculations. Single line diagram– Impedance diagram of a power system–Graph theory definition – Formation of element node incidence and bus incidence matrices – Primitive network representation, Y bus formation by direct and singular transformation methods.

UNIT-II Power Flow Studies (10 hours)
The necessity of power flow studies – Derivation of static power flow equations – Power flow solution using Gauss-Seidel Method – Newton Raphson Method (Rectangular and polar coordinates form) –Decoupled and Fast Decoupled methods – Algorithmic approach – Problems on 3–bus system only. Merits and demerits of different load flow techniques.

UNIT - III Symmetrical Components and Symmetrical Fault Analysis (10 hours)
Symmetrical Components: Synthesis of Unsymmetrical Phasors from their symmetrical components, symmetrical components of unsymmetrical phasors, Power in symmetrical components, Sequence impedances – Synchronous machine – Transmission line and transformers – Sequence networks.
Symmetrical fault analysis: Short circuit current and MVA calculations, fault levels, application of series reactors.

UNIT- IV Unsymmetrical Fault Analysis (10 hours)
Unsymmetrical fault analysis: Unsymmetrical Faults in power systems, Single Line to Ground Faults, Line to Line Faults, Double Line to Ground Faults, and Open-conductor Faults.

UNIT - V Power System Stability-I (10 hours)
Power System Stability Analysis Elementary concepts of Steady-state– Dynamic and Transient Stabilities– Description of Steady-State Stability Power Limit–Transfer Reactance–Synchronizing Power Coefficient – Power Angle Curve

UNIT-VI Power System Stability-II **(10 hours)**

Determination of Steady-State Stability –Derivation of Swing Equation, Multi-Machine stability studies, Determination of Transient Stability by Equal Area Criterion–Applications of Equal Area Criterion–Methods to improve steady-state and transient stability.

Learning Resources:

Textbooks:

1. John J Grainger, W.D. Stevenson, “Power System Analysis”, McGraw-Hill (India) Pub. Third Edition, 2011.
2. Kothari D. P. and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education; Fourth edition, 2011.
3. J Duncan Glover and M S Sarma, Thompson, “Power System Analysis and Design”, Third Edition 2006

Reference books:

1. C.LWadhwa, “Electrical Power Systems”, New Age International, Sixth Edition, 2012. Hadi Saadat, “Power System Analysis”, McGraw Hill, Second Edition, 2002.
2. S.S. Vadhera, “Power System Analysis & Stability”, Khanna Publishers, Fourth Edition, 2005.

Web resources:

1. Dr. B. Das, Computer-Aided Power System Analysis, IIT Roorkee NPTEL URL: https://nptel.ac.in/content/syllabus_pdf/108107028
2. Prof. AK Sinha, Power System Analysis, IIT Kharagpur. NPTEL URL: https://www.nptel.ac.in/courses/108105067/

Course outcomes: At the end of the course, the student will be able to

CO 1	Able to draw impedance diagrams for a power system network and to understand per unit quantities.
CO 2	Able to form a Ybus for power system networks.
CO 3	Able to find the fault currents for all types of faults to provide data for the design of protective devices.
CO 4	Able to analyze the steady-state, transient, and dynamic stability concepts of a power system.

Assessment Method

Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING THIRD YEAR: SEMESTER-I

23EE3181	**Power Systems Laboratory**	**PCC**	**0L: 0T: 3 P**	**1.5 credits**

Course Learning Objective

1. To learn the hardware components in the PS lab and get to know functioning
2. To perform experiments such as creating faults and see the response of CB and relay.
3. To perform experiments and testing and finding equivalent circuits etc.

List of Experiments

1. Calculation of Efficiency and Regulation for a Long Transmission line with R and RL Loads.
2. Calculation of ABCD Parameters for Short, Medium and Long Transmission Lines.
3. Characteristics of Percentage biased of Static/Electro Magnetic differential Relay.
4. Characteristics of Static Relay under Voltage/Over Voltage.
5. Measurement of % ratio error and phase angle of given current transformer by comparison.
6. Determination of Equivalent circuit of a 3-winding transformer.
7. Determination of positive, negative and zero sequences of a 3-winding transformer.
8. Determination of sequence impedances of a cylindrical rotor Synchronous Machine.
9. Fault Analysis on a Three Phase Transmission Line Model.
10. IDMT Characteristics of Over Current Relay.
11. Measurement of % ratio error and phase angle of given current transformer by comparison.
12. Measurement of % ratio error and phase angle of given potential transformer by comparison.
13. Simulation of String Insulators for Determination of Voltage Distribution and String Efficiency.

Course outcome : After the completion of this Laboratory course, the student will be able to

CO 1	To get the exposure of various components in a PS lab
CO 2	To experience the happening of faults and observe how the response systems are working
CO 3	Able to do experiments on finding wiring, finding relay faults etc.

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	15%	40%
End Semester Examination weightage (%)			60%

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ENGINEERING THIRD YEAR: SEMESTER-I

23EG3182	**English-II Laboratory**	**HSC**	**0L: 0T: 3 P**	**1.5 credits**

Course objectives:

1. To improve group discussion skills of the students
2. To help the students to write their CV and Internship application
3. To improve the telephonic etiquettes of the students
4. To help the students to take decision on their career

Course Content

UNIT-I
Group Discussion - How to think and analyze - How to initiate a topic - How to continue a topic - How to support or reject a point-of-view - How to defend your position - Managing distractions and mediating between contenders - How to summarize & conclude

UNIT-II
Telephonic conversation & Etiquette - How to introduce oneself - How to introduce the main issue - How to keep the other person engaged - How to convince the other person - How to complain without irritating. - Giving assurance and asking for clarification - How to end a formal telephonic conversation

UNIT-III:
Career Planning & Job-Skill Analysis - ASK: Talking about one's Attitudes, Knowledge, & Skills - SMART goals - Reading & Analysis of Job Advertisements

UNIT-IV:
CV & Resume Writing - Difference between CV & Resume - Writing CV - Writing Resume - Writing Cover Letter

UNIT-V
Application for Internship - Application for internship in Academic Labs - Application for internship in Industries - Follow up the Application with reminders and requests

UNIT-VI
Life Skills - Leadership communication - Interpersonal communication - Stress management - Time Management

Reference Books:

1. *Business Communication Today*, 12th Edition, Courtland L Bovee & John Thill, Pearson
2. British Council Material on Career Planning & Interviews
3. *Master the Group Discussion & Personal Interview - Complete Discussion on the topics asked by reputed B-schools & IIMs* by Sheetal Desarda, Notion Press
4. *Group Discussion and Interview Skills* by Priyadarshi Patnaik , Cambridge University Press India
5. *The Ultimate Guide to Internships: 100 Steps to Get a Great Internship and Thrive in It* by Eric Woodard

6. Telephone Etiquette by Robert DeGroot

Course outcomes: At the end of the course, the student will be able to

CO 1	Get used to a variety of GDs to understand the principles, finer nuances, and intricacies of the art
CO 2	Get exhaustive information on how to prepare for internship and interview
CO 3	Write his/her CV to remain well-prepared for the interviews
CO 4	Take decision on his/her career goals and plans
CO 5	Attain professional speaking skills to enhance his/her employability skills.

Assessment Method:

Course Nature: THEORY + LABORATORY

Internal Assessment (40 Marks)	**External Assessment** (60 Marks)
Record Writing – 10 Marks	Reading Comprehension – 15 Marks
Attendance – 10 Marks	Writing – 30 Marks
Continuous Assessment – 20 Marks (Listening – 10 M & Oral Presentations – 10 M)	Speaking (Viva-Voce) – 15 Marks

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ENGINEERING THIRD YEAR: SEMESTER-I

23EE3102	**Introduction to Electrical Vehicles**	**PCC**	**3L: 0T: 0P**	**3 credits**

Course Objectives:

1. To get familiar with EV ecosystem
2. To understand Energy and EV subsystems
3. To get familiar with Batteries
4. To gain knowledge about Battery pack and get introduced to design parameters
5. To familiarize with EV motors and controllers
6. To get familiar with Chargers and charging stations

Unit-1

Overview of EVs,Batteries, Chargers. EV Subsystems, Forces acting on a moving vehicle, Aerodynamic drag, Rolling Resistance and Uphill Resistance, Power and Torque to accelerate.

Unit-2

Concept of drive cycles, energy used per cycle. Design of EV subsystem

Unit-3

Introduction to Battery Parameters, Need of Li-ion batteries, Batteries in future, Li-ion battery cells. Concept and Estimation of SoC,SoH. Battery pack development, Battery charging Techniques.

Unit-4

Fundamentals of Battery pack design, Introduction to Thermal, Mechanical and Electrical design. Introduction to BMS design. Swapping.

Unit-5

EV Motors and Controllers - Understanding Flow, Power and Efficiency, Torque Production in PMSM, architecture,Speed and Back EMF. Building blocks of thermal circuits.

Unit-6

EV chargers: slow and fast chargers, Public chargers,Introduction to protocol,Location of Chargers.

Course outcomes:

CO1	Familiarize with EV ecosystem
CO2	Energy and EV subsystems
CO3	Concept of Batteries
CO4	Understand about Battery pack and design parameters

CO5	EV motors and controllers
CO6	Chargers and different charging stations

Text / References:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
2. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.

Web resources:

1. Fundamentals of Electric vehicles: Technology & Economics, IIT Madras
2. Prof. Ashok Jhunjhunwala Prof. Prabhjot Kaur Prof. Kaushal Kumar Jha Prof. L Kannan https://nptel.ac.in/courses/108106170

Assessment Method

Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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ENGINEERING SECOND YEAR: SEMESTER-I

23EE3182	**Electrical Vehicles Lab**	**PCC**	**0L: 0T: 3P**	**1.5 credits**

Course Learning Objective

1. To learn the hardware components and their maintenance, working principles etc.
2. To check the working and diagnose the condition of ignition and check the relay operations.

List of Experiments

1. Battery testing
2. Alternator testing
3. Starter motor testing
4. Diagnosis of ignition system
5. Diagnosis of automotive electrical wiring
6. Fault finding of relay & fuses in car using Off Board Diagnostics Systems (OBDS)
7. Relay & fuse Fault diagnostic of a car using OBDS
8. Simulation of equivalent circuit of a lead-acid and Li-Ion battery.
9. Simulation of battery parameters measurements and estimation
10. Passive battery management systems simulation
11. Active battery management systems simulation
12. Charging and discharging characteristics of a battery
13. Closed loop implementation of Bi-directional DC-Dc converter with two batteries
14. 2s, 4p battery pack design with passive BMS circuit
15. 4s, 4p battery pack design with active BMS
16. Simulation of battery charging by using non-isolated DC-DC converter
17. Simulation of battery charging by using non-isolated AC-DC converter
18. Simulation of battery charging system to analyze its impact on power distribution systems
19. Design and submission of lab project

Note: All the simulations must be performed and at least 6 experiments must be conducted in the hardware part.

Learning Resources

Textbooks

Mary Murphy, Electric and Hybrid Vehicles, Principles, Design and Technology, 2nd Edition

Reference books

Ioniq, I-Pace, Soul, Leaf, Zoe, Tesla S, X, 3, and e-Golf, Joining the Electric Vehicle Revolution

Web Resources

Course outcome After the completion of this Laboratory course, the student will be able to

CO 1	To learn the MATLAB environment, python scripting and its programming fundamentals
CO 2	Ability to write Programs using commands and functions
CO 3	Able to simulate and visualize the data of various formats
CO 4	Able to understand perform operations on applications related to different fields
CO 5	Able to perform simulation of a simple prototype design project in Electronics and communication and relevant fields

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	15%	40%
End Semester Examination weightage (%)			60%

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ENGINEERING THIRD YEAR: SEMESTER-I

23EC3126	**Embedded Systems**	**PCC**	**3L: 1T: 0P**	**3 credits**

Course Learning Objectives:

1. Students shall learn about evaluation of embedded systems
2. Students shall learn about PIC Unit
3. Students shall learn about ARM processors
4. Students shall learn about DSP processors
5. Students shall learn about software limitations in embedded systems
6. Students shall learn about networking of embedded systems

Course Content

Unit I **(6hours)**

Overview of Embedded Systems, Embedded System Architecture, Processor examples: ARM, PIC etc, Introduction to Embedded Hardware, Overview of micro controller and micro- processor, Vonnueuman Architecture, Hardvard Architecture, Advanced Hardvard Architecture, Introduction to PIC microcontroller.

Unit-II **(10 hours)**

Instruction format, Addressing modes, Instructions, Data transfer instructions, Arithmetic and Logical instructions, Bit oriented instructions, Control instructions, Assembly language programming, Interrupts in PIC, Interrupts timing, PIC input output pins, PIC timers, Watchdog timer, PWM mode in PIC, PIC peripherals, PIC examples.

Unit-III **(10hours)**

History, ARM Architecture and its versions, Basic ARM organization, Registers and its organization, Processor modes, Memory Organization, ARM Instruction set, ARM Data types, ARM interrupt processing, Stack organization, ARM input output system, Pipeline operation in ARM, Simple ARM based systems.

Unit-IV **(8 hours)**

Features of digital signal processors, DSP applications and DSP algorithms, DSP memory, Instruction sets and parallel instructions, System on chip, Memory, Memory organization, Virtual memory, Memory management Unit, BUS structure, Serial interfaces, Power aware architecture.

Unit-V **(6 hours)**

Requirement and features of software for embedded systems, Usage of C and java and its limitations, Fundamentals of embedded operating systems, Scheduling policies, Resource management, Embedded OS.

Unit-VI **(5 hours)**

Network embedded systems, Distributed embedded systems and its Architecture, Multi- processor networks, Ethernet and its features, Hardware modules, Protocols.

Learning Resources:

Textbooks

1. Wayne Wolf, 'Computers as components: Principles of Embedded Computing System Design', Morgan Kaufman publication, 2000.
2. Advanced Microprocessors and Peripherals – A. K. Ray and K. M. Bhurchandani, TMH, 2nd Edition 2006

Reference books:

1. Microprocessors and Interfacing, D. V. Hall, TMGH, 2nd Edition 2006.

Web resources:

2. Dr. Santanu Chaudhury, NPTEL-IIT Delhi, 'Embedded Systems', URL:https://nptel.ac.in/courses/108102045

Course outcomes: At the end of the course, the student will be able to

CO 1	Understand evaluation of embedded systems
CO 2	Analyse the PIC Unit
CO 3	Analyse the ARM processors
CO 4	Analyse the DSP processors
CO 5	Understand the software limitations in embedded systems
CO 6	Understand the networking of embedded systems

Assessment Method

Assessment Tool	Weekly tests (In semester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING THIRD YEAR: SEMESTER-I

23EC3181	**Embedded Systems Lab**	**PCC**	**0L: 0T: 3P**	**1.5 credits**

Course Content

1. Introduction to ARM Cortex M3 Processor
2. Introduction to Microcontroller Micro Controller
3. To understand the RISC-V Instruction Set Architecture through execution of programs

Experiments:

1. Assembly level program to multiply two 16 bit binary numbers.
2. To study development tools/environment for ATMEL/PIC microcontroller programs and architecture.
3. Serial Communication using (a). 8051 and (b). 8086.
4. Simple test program using ARM 9 mini 2440 kit (Interfacing LED with ARM 9 mini 2440 kit) (hardware/software modules)
5. Using the Internal PWM module of ARM controller generate PWM and vary its duty cycle (hardware/software modules)
6. ARM to PC communication via UART Transmit a message via UART of ARM and display it on terminal of PC) (hardware/software modules)
7. Familiarization with RISC-V tools (Ripes tool (or) any other open source tool)
8. Execution/Simulation of simple arithmetic operations on RISC-V tool
9. Execution/Simulation of advanced I/O operations, Cache operations, assembly debugging using RISC-V tool
10. Write a program to interface 2 relays with LPC2148) (hardware/software modules)
11. Design and submission of lab project

***ALP= Assembly level Program.**

Course outcomes: On successful completion of the course students will able to

CO 1	Understand the Architecture of ARM processor & its Registers
CO 2	Understand the Architecture and Interfacing of a Microcontroller
CO 3	Introduced to Assembly level programming and can implement basic operations
CO 4	Interface few basic devices with Micro controller.
CO 5	Control and Interface to devices to get a desired output.

Assessment Method

Assessment Tool	Experiments	Report/Viva-Voce/ Quiz/MCQ/Lab project	Total
Weightage (%)	25%	15%	40%
End Semester Examination weightage (%)			60%

ENGINEERING THIRD YEAR: SEMESTER-I

23HS3103	**Product Design and Innovation lab**	**HSC**	**1L: 0T: 0P**	**1 credit**

Course Learning Objectives

1. To make awareness of the product design process.
2. This course will give an understanding of methods, tools and techniques applied in product design.
3. This course will enhance the overview of innovation, product design process.
4. It will help to understand competitive benchmarking, aspects of human factors in product design, tools for creative concept.
5. one of the objectives of this course is to enable student for advance thinking in designing through case studies and hands-on exercises.
6. It will help students to generate creative ideas in to product design, considering human factors aspects along with its business plan

Course Contents

UNIT I **(4 hours)**

Introduction to product and Product design, difference between Product development and product design, Need for Innovation and design, user Innovation. Need Problem Identification, product study and market study

UNIT II **(3 hours)**

Importance of human factors in product design, physical ergonomics, principles and issues, ergonomic assessment tool, Cognitive issues in product design.

UNIT III **(2 hours)**

Creative techniques and tools, concept generation, concept evaluation, concept design and presentations.

UNIT IV **(4 hours)**

Product prototype, model making work flow for prototype, tools and techniques for model making and prototyping, introduction to prototype driven innovation

UNIT V **(7 hours)**

Selection of a product, Designing, marketability of product, Disciplined entrepreneurship canvas (Students need to fill up the canvas according to their selected product or services)

UNIT VI **(10 hours)**

Overview of final product, assignment submission with presentation

Learning resources

Text Books

1. Eppinger, S., & Ulrich, K., '*Product design and development*', McGraw-Hill Higher Education, 2015.

2. Green, W., & Jordan, P. W. (Eds.), '*Human factors in product design: current practice and future trends'*. CRC Press, 1999.

Reference Books

1. Sanders, M. S., & McCormick, E. J., '*Human factors in engineering and design'*, Mcgraw-Hill book company, 1993.
2. Roozenburg, N. F., & Eekels, J., '*Product design: fundamentals and methods*' (Vol. 2). John Wiley &Sons Inc., 1995.

Web resources:

1. Dr. Debayan Dhar, NPTEL-IIT Guwahati, 'Product Design and Innovation'. URL:https://nptel.ac.in/courses/107103082/

Course outcomes: At the end of the course, the student will be able to

CO 1	A student will be able to understand basic of production design
CO 2	This subject will provide implication facilities of methods, tools and techniques of production design.
CO 3	Students can be able to correlate human factor and competitive benchmarking in product design.
CO 4	Students can have practical experience by implementing theory in case studies.
CO 5	They can enhance their creativity in product design.
CO 6	They will be able to create their own product design with implementation of available theoretical knowledge.

*Note:

1. Industry personnel/start company founding personnel may be included in this course.
3. In Assessment Method, among one of the monthly seminars, the student is supposed to submit video recording of seminar and the same should be played in the classroom.

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ENGINEERING THIRD YEAR: SEMESTER-I

23EE3190	**Mini Project -1 (Socially Relevant Project)**	**PROJ**	**0L: 0T: 3P**	**1 credits**

Course Learning Objective

1. To introduce the student to the existing real-time societal problems
2. To make the student to identify a problem with the help of staff members
3. To see that students can propose elaborately and try attempting to solve the problem to great extent.

List of Experiments

1. Identifying real-time societal problems
2. Idea proposal of multiple-solutions for the problem identified and discussion
3. Prototype design for an optimal solution

Note: The student is supposed to use the latest advancements of IOT/AI and general understanding on science and technology for identifying solution to a problem

Course outcome: After the completion of this Laboratory course, the student will be able to

CO 1	To understand the problems the society facing at present specifically at university/institute/ locality etc level.
CO 2	Shortlist some of the problems and do an exercise to choose a problem to solve
CO 3	Form a group with classmates and peers (worldwide), local authorities and understand deeply the roots of the problem and start initiation of solving it.
CO 4	Propose a solution method and prepare either hardware or software models depending upon the problem demands
CO 5	See his/her solution impact on the society and see or submit/suggest the models to the authorities for further implementation after approval satisfying he IP rights of RGUKT.

Assessment Method

Assessment Tool	Literature survey (Internal)	Seminar on observed case- studies (Internal)	Hardware/Software prototype development for identified problem (External)	Final Presentation and Viva-Voce (External)
Weightage (%)	20 %	20%	40%	20%

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ENGINEERING THIRD YEAR: SEMESTER-II

23EG3283	**English-III Laboratory**	**HSC**	**0L: 0T: 3 P**	**1.5 credits**

Course objectives:

1. To improve interpersonal skills of the students
2. To help the students to write professional letters and reports
3. To practice the etiquettes to be used at workplace
4. To reward hands on experience on managing meetings
5. To imbibe leadership qualities in the students

Course Content

UNIT-I: (06 Contact Hours)
Professional Presentation - Collecting & Reading the materials to be presented - Analyzing the main points - Summarizing & concluding - Developing PPT - Delivery of the Presentation

UNIT-II: (06 Contact Hours)
Report Writing & Writing Professional Emails & Applications – Routine Reports – Investigative Reports - Professional Emails - Formal Letters and Applications

UNIT-III: (06 Contact Hours)
Agenda, Meetings, & Minutes - Setting the agenda for a meeting - Managing a meeting - Keynote address & vote of thanks - Publishing the minutes

UNIT-IV: (06 Contact Hours)
People skills and small talks (2 minutes) - Talking to professional executives - Talking to colleagues - Talking to the boss - Talking to your team - Talking to the media delegates

UNIT-V: (06 Contact Hours)
Corporate Etiquettes - How to introduce & greet - How to raise a question - How to clarify a doubt - How to say “yes” or “no” - Rapport building - Dining & winning - Counseling somebody - How to influence & motivate

UNIT-VI: (06 Contact Hours)
Life Skills - Leadership communication - Interpersonal communication - Stress management - Time

Managemen

References:

***Business Communication Today*, 12th Edition, Courtland L Bovee & John Thill, Pearson**
British Council Material on communication
Training in Interpersonal Skills: Tips f: Tips for Managing People at Work by **Robbins and Hunsaker**
Soft Skills for Everyone, with CD Paperback –by Jeff
Butterfield Communication for business by Shirley Taylor,
Pearson

Course outcomes: At the end of the course, the student will be able to

CO 1	The art of professional presentation
CO 2	Write professional reports and letters
CO 3	Conduct a formal meeting
CO 4	Develop people skills and corporate etiquettes
CO 5	Gain the basic knowledge about leadership communication, stress management and time management

Assessment Method:

Course Nature: LABORATORY

Internal Assessment (40 Marks)	**External Assessment** (60 Marks)
Record Writing10 Marks	Reading Comprehension – 15 Marks
Attendance 10 Marks	Writing– 30 Marks
Continuous Assessment (Listening – 10 Marks + Oral Presentations – 10 Marks)	Speaking (Viva-Voce) – 15 Marks

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ENGINEERING THIRD YEAR: SEMESTER-II

23HS3201	**Constitution of India**	**MC**	**1L: 0T: 0P**	**0 credits**

Course Learning Objectives

1. The basic objective of the course is to provide knowledge about institutions
2. It helps to understands the processes to governing the society in a systematic way.
3. It helps to establish social Justice, Liberty, Equity and Fraternity.
4. The course will introduce the idea of political system in general
5. It provides idea about working process of constitutional institutions.
6. To create awareness about the functioning of the judicial system in India.

Course Contents

Unit-I **(2 hours)**

Introduction-Constitution' meaning of the term, Indian constitution sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and duties, Directive Principles of State Policy.

Unit-II **(3 hours)**

Union Government and its Administration-Structure of the Indian Union: Federalism, centre-state relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok sabha, Rajya sabha.

Unit-III **(2 hours)**

Election commission- Election commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

Unit-IV **(2 hours)**

State Government and its Administration- Governor: Role and position, CM and Council of ministers, state secretariat: Organization, structure and functions.

Unit-V **(3 hours)**

Local Administration-District's Administration head: Role and importance, Municipalities: Introduction, Mayor and role of Elected Representatives, CEO of Municipal Corporation, Panchayati raj: Introduction, PRI: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role, Block level: Organizational Hierarchy (different departments), Village level: Role of elected and appointed officials, Importance of grass root democracy.

Unit-VI **(3 hours)**

Union Judiciary-Establishment and constitution of Supreme court, Appointment of Judges, Establishment of State High court, Establishment of common High court for 2 or more states, WRITS, PIL(Public Interest Litigation).

Learning resources

Text books

1. Durga Das Basu, *Constitutions of India*, 23rd ed, LexisNexis Publication.

Reference Books

1. Indian Polity by Laxmikanth
2. Indian Administration by Subhash Kashyap
3. Indian Administration by Avasti and Avasti
4. Government and Politics of India by W.H.Mrrison Jones Constitution of India by J.C.Johari

Web Resources

2. https://unacademy.com/

Course outcomes: At the end of the course, the student will be able to

CO 1	The students will understand their fundamental rules and duties.
CO 2	The students will learn the political system and the system of elections in India.
CO 3	It is to provide the students the institutions and processes to govern themselves in the manner they prefer.
CO 4	Students can also be able to utilize the laws and facilities provided by constution
CO 5	It will provide over all idea about our legal system.
CO 6	It will enable students more strong in terms of law and practice in day to day life.

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	0	0	100%	%100

**** PASS/FAIL course****

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ENGINEERING THIRD YEAR: SEMESTER-II

23HS3201	**Career Development Course**	**MC**	**2L: 0T: 0P**	**0 credits**

Course Learning Objectives:

1. To enhance holistic development of students and improve their employability skills
2. To instill confidence in students and develop skills necessary to face the challenges of competitive exams and placements

Course Contents

Unit I **(1.5 hours)**

Number system: Base System, Exponents, Factorials, LCM & HCF, Properties of Numbers, Remainders, Successive Divisions

Sequence & Series: Arithmetic Progression, Harmonic Progression, Geometric Progression. Programming in C

Unit II **(8 hours)**

Arithmetic: Averages, Clocks & Calendars, Simple Interest & Compoud Interest, Mixture & Alligations, Percentages, Profit, Loss & Discounts, Ratio & Proportion, Speed, Time & Distance, Time & Work

Algebra: Binomial Theorem, Complex Numbers, Functions, Higher Degree Equations, Inequalities , Linear Equations, Logarithm, Quadratic Equations Programming in C

Unit III **(6 hours)**

Geometry: Mensuration, Lines & Angles, Circles, Polygons, Triangles, Co-ordinate Geometry, Trigonometry

Probability & Statistics: Mean, Median & Mode, Permutation & Combination, Probability Set Theory & Venn Diagram Programming using Data Structures

Unit IV **(7 hours)**

Logical Reasoning: Logical Sequence, Premise, Assumption & Conclusion, Binary Logic, Blood Relations, Linear & Matrix Arrangement, Seating Arrangement, Coding & Decoding, Statements & Assumptions Puzzles.

Analytical Reasoning: Course of Action Fact, Inference & Judgement, Logical Deduction, Statement & Assumption, Strong & Weak Arguments, Syllogism Programming in Python

Unit V **(4.5 hours)**

Data Interpretation: Charts (Column, Pie & Bar), Tables Graphs (Line & Area), Venn Diagram, Data Sufficiency. **Programming using JAVA Reading Comprehension**

Unit VI **(3 hours)**

Verbal Ability: Cloze Test Error Spotting, Fill in the blanks, Sentence Correction, Word Usage, Para jumbles, Paragraph Completion, Paragraph Summary. Programming using JAVA

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Learning resources Text book

1. Sarvesh K Verma, *'Quantitative Aptitude Quantum CAT'*, arihant publications
2. Arun Sharma, Meenakshi Upadhyay, *' Verbal Ability and Reading Comprehension'* , McGraw Hill publications
3. Arun Sharma, *'Data Interpretation'*, McGraw Hill publications
4. Arun Sharma, *'Logical Reasoning'*, McGraw Hill publications

Reference books

1. Nishit K Sinha, 'Logical Reasoning and Data Interpretation', Pearson publications
2. Arun Sharma, *'Quantitative Aptitude'*, McGraw Hill publications

Web resources

1. https://unacademy.com
2. https://www.tutorialspoint.com/
3. https://www.indiabix.com/

Course outcomes: At the end of the course, the student will be able to

CO 1	Improve aptitude, problem solving skills and reasoning abilities
CO 2	Improve Verbal ability skills, Data interpretation skills
CO 3	Understand the basic techniques required for solving Reading Comprehension
CO 4	Familiarize with the written tests of competitive exams, campus placements and PSUs
CO 5	Collectively solve problems in teams and group
CO 6	Adopt and acquire new techniques in solving problem

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

**** Pass/Fail course.**

Note: All examinations will be only of objective type. CDPC team assistance is to be taken in preparation of question papers. For Monthly tests, negative marking may also be introduced

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

ENGINEERING FOURTH YEAR: SEMESTER-I

23BE4101	**Environmental Studies**	**MC**	**2L: 0T: 0P**	**0 credits**

Course Learning Objectives

1. To provide knowledge about multidisciplinary nature of environment, various sources of natural energy.
2. Understanding of ecosystem structure and function etc.
3. Knowledge of biodiversity and conservation
4. Understanding of problems caused by pollution and its impact
5. Understanding about the various social issues related to environment.
6. Awareness for the Environment and human health

Course Content

Unit-I **(5 hours)**

The Multidisciplinary Nature of Environmental Studies: Definition, scope and importance; Need for public awareness.

Natural Resources: Renewable and Non Renewable Resources:
Natural resources and associated problems.
a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources' for sustainable lifestyles.

Unit-II **(5 hours)**

Ecosystems: Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystem:-a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem, d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Unit-III **(5 hours)**

Biodiversity and It's Conservation: Introduction – Definition: genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-sports of biodiversity, Threats to biodiversity: habitat loss,

poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit-IV **(5 hours)**

Environmental Pollution: Cause, effects and control measures of:-a. Air pollution, b. Water pollution, c. Soil pollution, d. Marine pollution, e. Noise pollution, f. Thermal pollution, g. Nuclear hazards, Solid waste Management: Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies, Disaster management: floods, earthquake, cyclone and landslides.

Unit- V **(5 hours)**

Social Issues and the Environment: From Unsustainable to Sustainable development Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns. Case Studies, Environmental ethics: Issues and possible solutions.• Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act, Issues involved in enforcement of environmental legislation, Public awareness.

Unit-VI **(5 hours)**

Human Population and the Environment: Population growth, variation among nations, Population explosion – Family Welfare Programme, Environment and human health, Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and human health, Case Studies.

LearninResources

Text book

1. Erach Bharucha, '*Textbook of Environmental studies'*, UGC

Reference Books

1. Clark RS, '*Marine Pollution'*, Clanderson Press, Oxford (TB).
2. De AK, '*Environmental Chemistry'*, Wiley Eastern Ltd.

Course Outcomes: At the end of the course, the student will be able to

1	ll understanding about their surrounding natural resources and their servation
2	e to understand the ecosystem food chain and habitat.
3	velop the practices for conservation of biodiversity
4	well understand the pollution courses, impact and prevention from pollution
5	e to bring about an awareness of a variety of environmental concerns.

6	ttempts to create a pro-environmental attitude and a behavioral pattern in iety : is based on creating sustainable lifestyles.

Assessment Method

essment l	ekly tests	nthly tests	l Semester Test	al
ightage (%)	%	%	%	%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

Course code	Course Name	L-T-P	Credits
23EEXX45	Power System Protection and Switchgear	3-1-0	3

Course Objectives:

1. Circuit breakers: Learn the basic principles and operation of various types of circuit breakers.
2. Electromagnetic protective relays: Study the classification, operation, and application of different types of electromagnetic protective relays.
3. Generator and transformer protection: Understand protective schemes for generators and transformers.
4. Feeder and bus bar protection: Gain knowledge of various protective schemes used for feeders and bus bars.
5. Static relays: Explore the principle and operation of different types of static relays.
6. Overvoltage protection: Learn about different types of over voltages and the principles of protective schemes for insulation coordination.

UNIT 1:

Circuit Breakers Miniature Circuit Breaker(MCB)– Elementary principles of arc interruption– Restriking Voltage and Recovery voltages– Restriking phenomenon – RRRV– Average and Max. RRRV– Current chopping and Resistance switching– Introduction to oil circuit breakers– Description and operation of Air Blast– Vacuum and SF6 circuit breakers– CB ratings and specifications– Concept of Auto reclosing.

UNIT–2:

Electromagnetic Protection Relay connection – Balanced beam type attracted armature relay – induction disc and induction cup relays–Torque equation – Relays classification–Instantaneous– DMT and IDMT types– Applications of relays: Over current and under voltage relays– Directional relays– Differential relays and percentage differential relays– Universal torque equation– Distance relays: Impedance– Reactance– Mho and offset mho relays– Characteristics of distance relays and comparison.

UNIT–3:

Generator Protection of generators against stator faults– Rotor faults and abnormal conditions– restricted earth fault and inter turn fault protection– Numerical examples. Transformer Protection of transformers: Percentage differential protection– Design of CT's ratio– Buchholz relay protection–Numerical examples.

UNIT–4:

Feeder and Bus bar Protection of lines: Over current Protection schemes – PSM,TMS – Numerical examples – Carrier current and three zone distance relay using impedance relays–Protection of bus bars by using Differential protection.

UNIT–5:

Static and Digital Relays Static relays: Static relay components– Static over current relays– Static distance relay– Micro processor based digital relays

UNIT–6:

Protection against over voltage and grounding Generation of over voltages in power systems– Protection against lightning over voltages– Valve type and zinc oxide lighting arresters– Insulation coordination– BIL– impulse ratio– Standard impulse test wave– volt-time characteristics– Grounded and ungrounded neutral

systems–Effects of ungrounded neutral on system performance– Methods of neutral grounding: Solid–resistance–Reactance–Arcing grounds and grounding Practices.

Course outcomes: Upon completion of the course, students will:

CO1	Understand principles of arc interruption in high voltage circuit breakers (air, oil, vacuum, SF6).
CO2	Learn working principle and operation of electromagnetic protective relays.
CO3	Acquire knowledge of faults and protective schemes for high power generators and transformers.
CO4	Understand various protective schemes for feeders and bus bar protection.
CO5	Gain understanding of different types of static relays and their applications.
CO6	Comprehend different types of overvoltages and protective schemes for insulation coordination.

Learning Resources:

Text books:

1. Power System Protection and Switchgear by Badari Ram and D.N Viswakarma, TMH Publications
2. Power system protection- Static Relays with microprocessor applications.by T.S.MadhavaRao,TMH

Reference books:

1. Fundamentals of Power System Protection by Paithankar and S.R.Bhide.,PHI, 2003.
2. Art & Science of Protective Relaying – by C R Mason, Wiley Eastern Ltd.
3. Protection and SwitchGear by BhaveshBhalja, R.P. Maheshwari, NileshG.Chothani, Oxford University Press, 2013

23EEXX46	Measurements and Instrumentation	3L: 1T: 0P	3 credits

Course Objectives:

1. To understand the basic operation of different measuring instruments and thereby able to choose appropriate instruments for measuring different parameters.

Course Contents:

Unit-I: Measurements **(10 hours)**

Errors & classification, Measurement of voltage & current - permanent magnet moving coil and moving iron meters, Digital voltmeters and automation, guarding techniques.

Unit-II: Measurement of power and energy **(8 hours)**

Induction instruments, kVAh and kVARh meters, maximum demand indicators, digital multi-meters. Microprocessor based meters, Multifunctional meters, and algorithms for energy estimation**.**

Unit-III: Instrument transformers **(8 hours)**

Current and Potential transformers. Spectrum Analyzers, Data & Logic Analyzers.

Transducers Position transducers, force transducers, piezo-electric transducers, Hall effect transducers. Temperature measurement.

UNIT- IV: DC & AC Bridges **(12 hours)**

Method of measuring low, medium and high resistance – sensitivity of Wheat-stone's bridge – Carey Foster's bridge, Kelvin's double bridge for measuring low resistance, measurement of high resistance – loss of charge method. Measurement of inductance- Maxwell's bridge, Hay's bridge, Anderson's bridge - Owen's bridge. Measurement of capacitance and loss angle –Desaunty's Bridge - Wien's bridge – Schering Bridge.

Unit-V: Signal sources **(10 hours)**

Oscillators, Function generator & pulse generators. Oscilloscopes - CRO, Digital storage, Digital Phosphor Oscilloscopes. Analog & Digital Recorders and printers.

Unit-VI: Signal conditioners **(10 hours)**

Instrumentation amplifiers, voltage–current converters, voltage-frequency converters, analog multiplexers and de-multiplexers. Microprocessor Based Measurements, sampling frequency, Case Studies in Instrumentation.

Text Books:

1. K. Sawhney, 'A Course in Electrical and Electronic Measurements and Instrumentation', Dhanpat

Rai & Co., 9th Edition, 2015.
2. Bouwens A. J., 'Digital Instrumentation', Tata McGraw Hill Publications, 16th Reprint (2008).
3. Kalsi H.S, 'Electronic Instrumentation', Tata McGraw-Hill Education, 3rd Edition, 2010
4. Deobelin, 'Measurements Systems', Tata McGraw Hill Publications, 2nd Edition, 2010.

Reference Books:

1. W. D. Cooper, 'Electronic Instrumentation and Measurement Techniques', Prentice Hall of India Publications, 1st Edition, 2009.
2. Rangan C.S., 'Instruments Devices and System', Tata McGraw Hill Publications, 2nd Edition, 2009

Course outcomes: Upon completion of the course, the student will be able to

CO 1	Describe the working principle of different measuring instruments.
CO 2	Choose appropriate measuring instruments for measuring various parameters in their laboratory courses.
CO 3	Correlate the significance of different measuring instruments, recorders and oscilloscopes
CO 4	Develop a micro-processor based measuring unit for any practical application.

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX11	High Voltage Engineering	4L: 0T: 0P	3 credits

Course Objectives:

1. To deal with the detailed analysis of Breakdown occurring in gaseous, liquids and solid dielectrics
2. To inform about generation and measurement of High voltage and current
3. To introduce High voltage testing methods

UNIT – I: Breakdown in Gases **(8 hours)**

Ionization processes and de-ionization processes, Types of Discharge, insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge.

Unit-II: Breakdown in Liquids **(8 hours)**

Breakdown in Liquids and Solid Insulating Materials Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

UNIT – III: Generation of High Voltages **(6 hours)**

Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

UNIT- IV: Measurements of High Voltages **(6 hours)**

Measurements of High Voltages and Currents Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

UNIT – V: Lightning and switching **(8 hours)**

Lightning and switching over-voltages Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching over voltages, Protection against over-voltages, Surge diverters, Surge modifiers.

UNIT – VI: High Voltage Testing of Electrical Apparatus **(8 hours)**

High Voltage Testing of Electrical Apparatus and High Voltage Laboratories Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment.

Text books:

1. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 2007.

Reference books:

1. D. V. Razevig (Translated by Dr. M. P. Chourasia), "High Voltage Engineering Fundamentals", Khanna Publishers, 1993.
2. E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication, 2000.
3. R. Arora and W. Mosch "High Voltage and Electrical Insulation Engineering", John Wiley & Sons, 2011.

Course outcomes: At the end of the course, the student will be able to

CO1.	Understand the basic physics related to various breakdown processes in solid,

	liquid and gaseous insulating materials.
CO2.	Knowledge of generation and measurement of D. C., A.C., & Impulse voltages.
CO3.	Knowledge of tests on H. V. equipment and on insulating materials, as per the standards.
CO4.	Knowledge of how over-voltages arise in a power system, and protection against these over voltages.

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX09	**Electric Drives**	**3L: 1T: 0P**	**3 Credits**

Course Learning Objectives:

1. To introduce the drive system and operating modes of drive and its characteristics.
2. To understand Speed – Torque characteristics of different motor drives by various power converter topologies
3. To appreciate the motoring and braking operations of drive.
4. To differentiate DC and AC drives

Course Content:

Unit-I: Review of Conventional Drives (6 hours)
Speed–torque relation, Steady state stability, methods of speed control, braking for DC motor, Multi quadrant operation, Speed torque relation of AC motors, Methods of speed control and braking for Induction motor, Synchronous motor. Criteria for selection of motor for drives.

UNIT-II: Converter Control of DC Drives (8 hours)
Analysis of series and separately excited DC motor with single phase and three phase converters operating in different modes and configurations.

Unit-III: Chopper Control of DC Drives (8 hours)
Analysis of series and separately excited DC motors fed from different choppers for both time ratio control and current limit control, four quadrant control.

Unit-IV: Design of DC Drives (6 hours)
Single quadrant variable speed chopper fed DC drives, Four quadrant variable speed chopper fed DC Drives, Single phase/three phase converter, Dual converter fed DC Drive, current loop control, Armature current reversal, Field current control, Different controllers and firing circuits, simulation.

Unit-V: Inverter fed AC Drives (8 hours)
Analysis of different AC motor with single phase and three phase inverters Operations in different modes and configurations, Problems and strategies.

Unit-VI: Inverter fed AC Drives cntd. (6 hours)
Analysis of different AC motor with single phase and three phase cycloconverters. Operations in different modes and configurations.
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Learning Resources:
Text Books:

1. G K Dubey, Fundamentals of Electric Drives, CRC Press, 2002.
2. Murphy J.M.D, Turnbull, F.G, “Thyristor control of AC motor, Pergamon press, Oxford, 1988.
3. M.H. Rashid, "Power Electronics Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994
4. N. Mohanet.al."Power Electronics-Converters, Applications and Design”, John Wiley & Sons(Asia)Private Ltd.,Singapore,1996.

5. R. Krishnan, “Electric motor drives: modeling, analysis and control, Pearson.

Reference Books:

1. Sheperal, Wand Hully, L.N. “Power Electronic and Motor control” Cambridge University Press Cambridge 1987
2. Dewan S. Slemon B., Straughen, A.G.R., “Power Semiconductor drives”, John Wiley and Sons, New York 1984.

Course outcomes: Upon completion of the course, the student will be able to

CO 1	Identify the drawbacks of speed control of motor by conventional methods
CO 2	Differentiate Phase controlled and chopper-controlled DC drives speed-torque characteristics merits and demerits
CO 3	Understand Ac motor drive speed–torque characteristics using different control strategies its merits and demerits

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX47	**Advanced Control Systems**	**3L: 1T: 0P**	**3 Credits**

Course Learning Objectives:

1. To understand and design discrete time control system.
2. To design PID controller using Ziegler-Nichols method.

Course Content :

Unit-I: Review of Modeling and Analysis of LTI Systems

Modeling of physical Systems. Design specifications and performance indices, Motion control systems, Transportation lags. Approximation of time-delay functions, Sensitivity of control systems to parameter variations. Effects of disturbance of signals. Disturbance rejection.

Unit-II: Analysis in state-space

A perspective on state-space design. State variables. State models for physical systems. SISO and MIMO systems. Solution of state equations. Transfer function. Eigen values and Eigen vectors. Jacobian linearization technique. State transformations and diagonalization. Transformation to phase-variable canonical form Controllability and observability. Duality property Stability.

Unit-III: Feedback control design

Continuous control design Proportional, derivative and integral control action. PID controller tuning rules Ziegler-Nichols method. Two degree of freedom control systems. Compensator design using Bode diagram in frequency response approach. Lag-Lead, Lag-lead compensator. Control law design for full state feedback by pole placement. Full order observer system. Observer based state feedback. Separation principal.

Unit-IV: Introduction to Discrete-time Systems

Basic elements of discrete-time control system. Z-transform and properties. Inverse Z-transform. Difference equation and its solution by Z-transform method. Z-transfer function. State diagram of digital systems. Time delay. Direct, cascade and parallel decomposition of Z-transfer functions. Stability in Z-domain, Zury's test.

Unit-V: Non-linear system

Classification and types of non-linearity. Phenomena peculiar to non-linear systems. Methods of analysis. Linearization based on Taylor's series expansion Jacobian Linearization.

Unit-VI: Non-linear system cntd

Phase trajectory and its construction. Phase-plane analysis of linear and non-linear systems. Existence of limit cycles. Describing function of typical non-linearities. Stability analysis by DF method. Introduction to DIDF. Popov's circle criterion. Stability analysis by Lyapunov' direct and direct methods, Lypunov'stheorem.

Text Books:

1. Ogata. K , Modern Control Engineering, PHI Learning
2. Kuo B.C. , Automation Control Systems, Prentice Hall

Reference Books:

1. Roy Choudhury D , Modern Control Engineering, Prentice Hall

2. Nagrath J.J., Gopal M, Control System Engineering, New Age Pub.
3. Schulz, D.G. and Mels..L., State Functions and Linear Control Systems, McGraw-Hill.
4. Stepheni, Shahian, Savant, Hostetler Design of feedback control systems, Oxford University Press.

Course outcomes: Upon completion of the course, the student will be able to

CO 1	To understand control strategies for non linear systems
CO 2	To understand feedback control design
CO 3	To understand design of PID controller
CO 4	To understand discrete time control systems

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX48	Renewable energy systems	3L: 1T: 0P	3 Credits

Course Objectives:

1. To study the physics of wind power and energy
2. To understand the principle of operation of wind generators
3. To know the solar power resources
4. To analyze the solar photo-voltaic cells
5. To discuss the solar thermal power generation
6. To identify the network integration issues

Course contents:

UNIT - I Wind Power **(10 hours)**

Physics of Wind Power History of wind power, Indian and Global statistics, Wind physics, Betz limit ratio, stall and pitch control, Wind speed statistics-probability distributions, and Wind power-cumulative distribution functions.

UNIT - II Wind Power cntd **(10 hours)**

Wind Generator Topologies Review of modern wind turbine technologies, Fixed and Variable speed wind turbine, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator configurations, Converter Control.

UNIT – III: Solar power **(10 hours)**

The Solar Resource Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

UNIT – IV: Solar power cntd. **(10 hours)**

Solar Photovoltaic Technologies-Amorphous, mono-crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power point Tracking (MPPT) algorithms. Converter Control.

UNIT - V Fuel Cells **(10 hours)**

The Fuel Cell-Low and High Temperature Fuel Cells Constructional Features of Proton Exchange-Membrane Fuel Cells–Reformers-Electrolyzer Systems and Related Precautions-Advantages and Disadvantages of Fuel Cells-Fuel Cell Equivalent Circuit-

UNIT - VI Network Integration Issues **(10 hours)**

Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Text books:

1. T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd., 2005.
2. G. M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2004.

Reference books:

1. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.
2. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and

Sons Ltd., 2006.
3. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004. J.
4. A. Duffie and W. A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & Sons, 1991.

Course Outcomes: At the end of this course, students will demonstrate the ability to

1.	Understand the energy scenario and the consequent growths of the power generate renewable energy sources.
2.	Understand the basic physics of wind and solar power generation.
3.	Understand the power electronic interfaces for wind and solar generation.
4.	Understand the issues related to the grid-integration of solar and wind energy systems

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX49	**HVDC and FACTS**	**3L: 1T: 0P**	**3 Credits**

Course Learning Objective:

1. To compare EHV AC and HVDC systems .
2. To analyze Graetz circuit and also explain 6 and 12 pulse converters
3. To control HVDC systems with various methods and to perform power flow analysis in AC/DC systems.
4. To describe various protection methods for HVDC systems and Harmonics

Course Content:

Unit-I: HVDC Transmission:
DC Power Transmission: Need for power system interconnections, Evolution of AC and DC transmission systems, Comparison of HVDC and HVAC Transmission systems, Types of DC links, relative merits, Components of a HVDC system, Modern trends in DC Transmission systems.

Unit-II: Analysis of HVDC Converters:
Pulse number, choice of converter configurations, Analysis of Graetz circuit with and without overlap, voltage waveforms, Analysis of two and three valve conduction mode, Converter Bridge characteristics, Inverter mode of operation, voltage waveforms

Unit-III: Converter and HVDC Control:
Principles of DC link control, Converter Control characteristics, Control hierarchy Constant current Control, CEA Control, firing angle control of valves, starting and stopping of a dc link, Power control

Unit-IV: Harmonics and Filters:
Ill effects of Harmonics, sources of harmonic generation, Types of filters–Design examples, elimination of harmonics by using converters.

Unit-V: Power Flow Analysis in AC/DC Systems:
Modeling of DC links, solutions of AC-DC Power flow

Unit-VI: Flexible AC Transmission Systems (FACTS):
FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters, Basic types of FACTS controllers, shunt and series controllers, Current source and Voltage source converters. Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power

Learning Resources:
Text Books:

1. K.R. Padiyar, HVDC Power Transmission Systems–Technology and System Interactions" New Age International Publishers.
2. Narain G. Honorani, Laszlo Gyugyi "Understanding FACTS–Concepts and Technology of Flexible AC Transmission Systems"

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

CO1	Evaluate HVDC and EHVAC transmission
CO2	Analyze converter configurations used in HVDC and list the performance metrics.
CO3	Understand controllers for controlling the power flow through a dc link and compute filter parameters
CO4	Apply impedance, phase angle and voltage control for real and reactive power flow in ac transmission systems
CO5	Analyze and select a suitable FACTS controller for a given power flow condition

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX50	**Distribution System Planning and Automation**	**3L: 1T: 0P**	**3 Credits**

Course Learning Objective:

1. To distinguish between transmission and distribution systems.
2. To understand design considerations of feeders
3. To understand about Distribution transformers.
4. To examine the power factor improvement and voltage control

Course Content:

Unit-I: Power sector in India **(10 hours)**

An overview of distribution systems, Distribution system planning-issues and aspects, Introduction to Distribution system forecasting techniques, Stochastic and time series techniques for forecasting, intelligent techniques based load forecasting techniques, Definitions and importance of various terms that characterize loads, Load management and types of tariffs

Unit-II: Distribution transformers (DTRs): **(10 hours)**

Basic design considerations, 3-ph and 1-ph DTRs-types of connections and its relevance in operation, Need for special types of distribution transformers, Cast resin, CSP, Amorphous core DTRs, Regulation and efficiency of transformers-use of predetermined curves

Unit-III: Sub-transmission system: **(10 hours)**

Sub-stations site selection procedure, Sub-station capacity expansion, Location of new sub-stations and their rating, Sub-station bus schemes, VD and PL calculations for a service area with four and six feeders, VD and PL calculations for a service area with n-feeders, Characteristics of primary systems, Voltage drop(VD) and power loss(PL) calculations, Importance of power factor in distribution systems, Capacitors and their role in improving power factor. OLTC

Unit-IV: Distribution system protection: **(6 hours)**

Distribution system protection devices, Problems in distribution systems and the need for automation. Radial systems, ring main systems, advantages and disadvantages.

Unit-V: Distribution system automation(DSA): **(8 hours)**

General schematic, DSA-Hardware modules and their functions, DSA-Software modules and their functions, DSA-Alternatives in Communication media, Communication protocols for DSA schemes and need for OSA, Examples of DSA schemes, Distribution system grounding.

Learning Resources:

Text Books:

1. Turan Gonen, Electric power Distribution System Engineering, CRC Press, II Edition
2. A. S. Pabla, Electric Power Distribution, TMH, Fifth Edition

3. James A Momoh: Electric Power Distribution, Automation, Protection and Control, CRC Press

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

CO1	Understand the characteristics and components of electric power distribution systems.
CO2	Analyze and evaluate the impact of geographical, demographical and economic factors on distribution systems
CO3	Understand the components of distribution automation systems.
CO4	Design, analyze and evaluate distribution system design based on forecasted data

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX03	**Power System Protection**	**3L: 1T: 0P**	**3 credits**

Course Learning Objectives: Describe how electric power systems are protected and how speed, dependability, and security are ensured. Be familiar with the protection requirements for generators, power lines, and transformers in an electric energy system. The main protection functions and their protection schemes are described in detail and the settings for them are computed.

Course Content

Unit-I :Numerical Relaying **(6 Hours)**

Introduction to Numerical Relaying- Faults in power system, Elements and features of protection scheme, Fault analysis review-sequence components, Numerical relaying concept. Phasor estimation-Discrete Fourier transform(DFT), recursive and Half cycle DFT, Least square technique, Frequency response of phasor estimation techniques in the presence of decaying DC.

Unit-II: Overcurrent protection **(6 Hours)**

Overcurrent protection-Overcurrent Relay Characteristics, Overcurrent Relay Coordination, Relay Coordination with Fuse. Directional Relaying- Introduction to Directional Relaying, Positive Sequence Directional Relay, Negative and Zero Sequence Directional Relay, Superimposed Component Based Directional Relaying

Unit-III: Distance Relaying **(8 Hours)**

Distance Relaying- Introduction to Distance Relay, Fault Classification, Apparent Impedance Calculation, Distance Relay Implementation, Application to Double Circuit Line, Multi-terminal Lines, Protection of series compensated lines. Effect of Fault Resistance, Load Encroachment, Power Swing, Power Swing Detection Techniques, Adaptive Distance Relaying, Communication Assisted Relaying Scheme

Unit-IV: Transformer protection **(8 Hours)**

CT and CVT response, Fiber Optic Sensors, Transformer protection-Introduction to Transformer Protection, Differential Relay, Steps in Differential Relay Processing, Inrush Detection, CT Saturation, Negative Sequence Differential and Restricted Earth Fault Relay

Unit-V: Differential protection **(8 Hours)**

Differential protection of Line, Bus bar protection, Network Protection with Renewable sources- Fault Characteristics of Renewable Sources, Protection Challenges of Distribution Systems with Renewables, Protection challenges of transmission systems with renewable sources

Unit-VI:Wide Area Measurement **(7 Hours)**

Traveling wave approach-Traveling Wave Basics, Protection using Traveling Waves, Fault Location using Traveling Wave. Wide Area Measurement Basics, Wide Area Measurement for Protection. PMU.

Learning Resources:

Text Books

1. *Computer relaying for power systems*- A. G. Phadke and J S Thorp, John Wiley and Sons Ltd 2009
2. Modern solutions for protection, control, and monitoring of electric power systems

Reference Books

1. *Power system relaying*- S. H. Horowitz and A. G. Phadke, John Wiley and Sons Ltd 2008

2. *Numerical differential protection*: Principles and Applications. G. Ziegler, 2012, Wiley

Web Resources

1. **https://onlinecourses.nptel.ac.in/noc23_ee101/course**

Course outcomes: On successful completion of the course students will able to

CO 1	By identifying and formulating advanced problems and applying mathematics and science knowledge, students will demonstrate their ability to solve them
CO 2	Demonstrate the operation of a protective relay with simulated data by designing and coding it
CO 3	Analyze fault conditions for a small electric energy system under transient and steady state faults by developing algorithms and implementations
CO 4	Understand the main protection functions for component protection, such as overcurrent, directional, differential, distance, over/under voltage, over/under frequency, volts over hertz, and out-of-step protection.
CO 5	Developing and implementing special protection systems using traveling wave phenomena; developing and implementing special protection systems using state estimation

23EEXX08	Switched Mode Power Conversion	3L:1T:0P	3 Credits

Course Learning Objective:

1. To understand different non isolated and transformer-isolated power converters.
2. To understand analysis and design of switching regulator control.
3. To understand advanced techniques to improve efficiency and power density, such as use of resonant and soft-transition power converters.

Course Content:

Unit-I: DC/DC Converters (6 hours)

Basic topologies of buck, boost converters, buck-boost converters, and buck converter, isolated DC/DC converter topologies—forward, and fly-back converters, half and full bridge topologies, modeling of switching converters.

Unit-II: Current Mode and Current Fed Topologies (8 hours)

Voltage mode and current mode control of converters, peak and average current mode control, its advantages and limitations, voltage and current fed converters.

Unit-III: Resonant Converters (8 hours)

Need for resonant converters, types of resonant converters, methods of control, phase-modulation technique with ZVS in full-bridge topology, series resonant converter and resonant transition converter.

Unit-IV: Converter Transfer Functions (6 hours)

Application of state-space averaging to switching converters, derivation of converter transfer functions for buck, boost, and fly-back topologies.

Unit-V: Power Converter Design (8 hours)

Design of filter inductor& capacitor, and power transformer, Ratings for switching devices, current transformer for current sensing, design of drive circuits for switching devices, considerations for PCB layout.

Unit-VI: Controller Design (8 hours)

Introduction, mechanisms of loop stabilization, shaping E/A gain vs. frequency characteristic, conditional stability in feedback loops, stabilizing a continuous mode forward converter and discontinuous mode fly-back converter, feed-back loop stabilization with current mode control, the right-half plane zero.

Learning Resources:

Text Books:

1. Ned Mohan Tore M. Undeland: Power Electronics: Converters, Applications, and Design, Edition3, John Wiley & Sons, 2007.
2. Abraham I. Pressman, “Switching Power Supply Design”, Mc Graw Hill International, Second Edition, 1999.

Reference books:

1. P.C. Sen, Modern Power Electronics, S. Chand-2004.

2. Andrzej M. Trzynadlowski Introduction to Modern Power Electronics, 2nd Edition, illustrated Publisher John Wiley & Sons, 2010.
3. Muhammad H. Rashid, Power electronics hand book, ISBN: 81 8147 367 1

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

CO1	Understand isolated and non-isolated DC-DC converters and their operation in continuous conduction mode and discontinuous conduction mode.
CO2	Calculate minimum inductance, capacitance in single switch DC-DC converters.
CO3	Apply current control and voltage control methods to regulate the output power.
CO4	Design DC-DC converters and evaluate the stability of the system

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX51	**Smart Electric Grid**	**3L:1T:0P**	**3 Credits**

Course learning objective:

This course mainly focuses on basic fundamentals of smart grid for its implementation in the existing power system network. This course provides an overview of smart grid and its applications in potential sectors of Modern power systems. It also provides detailed utility level analysis in terms of energy management, network analysis and operation of smart grids. The course also explores issues in management, control, protection and monitoring of the grid with renewable energy source integration as well as in micro grids at remote locations.

Course content:

Unit I: Introduction to Smart Grid: (6 hours)

Issues related to conventional grids, Initial Overview of various smart grid measurement and communication technologies, smart grid protocols, Difference between conventional & smart grid, Architecture of Smart Grid, Smart Grid Initiative for Power Distribution Utility in India.

Unit II: Enablers for Smart Grid Technology (6 Hours)

Overview of Multi-agent System, Distributed Intelligence, Big Data Analysis, Cloud Computing, Software-Defined Networks (SDN), smart meters.

Unit III: Smart Grid Decision Support and operational technology (10 Hours)

Concepts of Visualization, Self-Healing, Congestion Management, Dynamic OPF, Security Assessment, Contingency Analysis, Dynamic State estimation, Stability Analysis, Intelligent Fault Management, Feeder Reconfiguration, Short Circuit Analysis, Topology Processing, Power Quality, Voltage VAR Control, advanced control of generators, improved FACTS devices

Unit IV: Smart Analytics (8 Hours)

Computational Intelligence, Wide Area Monitoring and Control Techniques, Demand Response Management, Predictive Asset Management, Forecasting Techniques

Unit V: New technology Integration (8 Hours)

Renewable Integration, Plug-in Electric Vehicle, Smart home and Smart City concepts, Cooperative grids

Unit VI: Smart Grid Market and Economics (7 Hours)

Energy market overview, Role of System Operators, DSO, and TSO under the smart grid, Transactive Energy

Learning Resources:

Text Books

1. Lars T. Berger and Krzysztof Iniewski, “Smart Grid Applications, Communications, And Security,” Wiley, New Delhi, Aug 2015
2. Buchholz, Bernd M., Styczynski, Zbigniew, “Smart Grids – Fundamentals and Technologies in Electricity Networks”, Springer, 2014
3. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, and Nick Jenkins, “Smart Grid: Technology And Applications,” Wiley, New Delhi, Aug 2015.

Reference Books

1. James Momoh, “Smart Grid: Fundamentals of Design and Analysis,” (I E E Power Engineering Series)– Wiley-Blackwell, Apr 2012
2. Takuro Sato, Daniel M. Kammen, Bin Duan, Martin Macuha, Zhenyu Zhou, and Jun Wu, “Smart Grid

Standards: Specifications, Requirements, and Technologies," WileyBlackwell, Apr 2015.
3. Chen-Ching Liu, Stephen McArthur, Seung-Jae Lee, "Smart Grid Handbook", 3 Volume Set, Wiley, USA, 2016

Web Resources:

1. https://nptel.ac.in/courses/108107113

Course outcomes: On successful completion of the course students will able to

CO 1	Summaries various aspects of the smart grid Technologies, Components, Architectures and Applications
CO 2	Study and compare modern communication infrastructure and justify the feasibility of the same for smart grid applications.
CO 3	An overview of smart grid and its applications in potential sectors of Modern power systems.
CO 4	Provides detailed utility level analysis in terms of energy management, network analysis and operation of smart grids.
CO 5	The course also explores issues in management, control, protection and monitoring of the grid with renewable energy source integration as well as in micro grids at remote locations.
CO 6	Provides overview of the Smart Grid Market and Economics

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXY52	**Introduction to Machine Learning**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives

1. To provide abroad survey of approaches and techniques in machine learning.
2. To develop a deeper understanding of several major topics in machine learning.
3. To develop the basic skills necessary to pursue research in machine learning.

Course Content:

Unit-I: Introduction (6hours)

Introduction, Different types of Learning, Hypothesis space and Cross-Validation, Linear Regression, Introduction to decision trees, learning decision trees, over fitting, Python exercise on decision trees and linear regression

Unit-II: KNN (7 hours)

K-Nearest neighbor, feature selection, feature extraction, collaborative filtering, python exercise on KNN and PCA.

Unit-III: Bayesian Learning (8hours)

Bayesian Learning, Naïve Bayes, Bayesian Network, Python exercise on Naïve Bayes

Unit-IV: SVM (8 hours)

Logistic regression, Introduction to Support Vector Machine, SVM: The Dual formation, SVM: maximum margin with noise, nonlinear SVM and Kennel function, SVM: solutions to the dual problem, Python exercise on SVM.

Unit-V: MLP(8hours)

Multilayer Neural network, neural network and back propagation algorithm, deep neural network, python exercise on neural network.

Unit-VI: Clustering (8 hours)

Introduction to computational learning theory, sample complexity: finite hypothesis space, VC Dimension, Introduction to Ensembles, Bagging and Boosting, Clustering, means clustering, agglomerative hierarchical clustering, python exercise on clustering.

Learning Resources:

Text Books:

1. Tom Mitchell, Introduction to Machine Learning, TMH 2nd Edition.

2. Ethem Alpaydin, Introduction to Machine Learning, PHI, 2nd Edition.

Reference Books:

1. Andreas C. Müller, Sarah Guido, Introduction to Machine Learning with Python O'Reilly Media, Inc. First Edition.

Web resources:

1. Prof. Sudeshna Sarkar, NPTE-IT-Kharagpur, Introduction to Machine Learning URL: http://nptel.ac.in/courses/106105152/

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the fundamental issues and challenges of machine learning like data, model selection, and model complexity.

CO2	Understand approaches, strengths and weaknesses of many popular machine learning algorithms
CO3	Design and implement various machine learning algorithms in a range of real world applications.

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX53	**AI Techniques in Electrical Engineering**	**3L:1T:0P**	**3 Credits**

Course learning Objective:

1. To locate soft commanding methodologies, such as artificial neural networks, Fuzzy logic and genetic Algorithms.
2. To observe the concepts of feed forward neural networks and about feedback neural networks.
3. To practice the concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control
4. To analyze genetic algorithm, genetic operations and genetic mutations.

Course content:

Unit-I: Artificial Neural Networks:

Introduction, Models of Neuron Network-Architectures–Knowledge representation, Artificial Intelligence and Neural networks–Learning Process-Error correction learning, Hebbian learning–Competitive learning- Boltzmann learning, supervised learning-Unsupervised learning–Reinforcement learning-Learning tasks.

Unit-II: ANN Paradigms:

Multi-layer perceptron using Back propagation Algorithm (BPA), Self Organizing Map (SOM), Radial Basis Function Network-Functional Link Network(FLN), Hopfield Network.

Unit-III: Fuzzy Logic

Introduction –Fuzzy versus crisp, Fuzzy sets-Membership function –Basic Fuzzy set operations, Properties of Fuzzy sets–Fuzzy cartesion Product, Operations on Fuzzy relations–Fuzzy logic–Fuzzy Quantifiers, Fuzzy Inference-Fuzzy Rule based system, Defuzzification methods

Unit-IV: Genetic Algorithms:

Introduction-Encoding–Fitness Function-Reproduction operators, Genetic Modeling–Genetic operators-Crossover-Single site crossover, Two point crossover–Multipoint crossover-Uniform crossover, Matrix crossover-Crossover Rate-Inversion& Deletion, Mutation operator–Mutation–Mutation Rate-Bit-wise operators, Generational cycle-convergence of Genetic Algorithm.

Unit-V: Applications of AI Techniques:

Load forecasting, Load flow studies, Economic load dispatch, Load frequency control, Single area system and two area system, Small Signal Stability (Dynamic stability), Reactive power control, Speed control of DC and AC Motors.

Learning Resources:

Text Books:

1. S. Rajasekaran and G.A.V.Pai Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, New Delhi,2003.
2. Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill, 2011

Reference books:

1. P.D. Wasserman; Neural Computing Theory & Practice, Van Nostr and Reinhold, NewYork, 1989.

2. Bart Kosko, Neural Network& Fuzzy System, PrenticeHall,1992

3. D.E. Goldberg, Genetic Algorithms, Addison-Wesley1999.

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

CO1	Understand concepts of ANNs, Fuzzy Logic and Genetic Algorithm.
CO2	Remember difference between knowledge based systems and Algorithmic based systems.
CO3	Understand operation of Fuzzy Controller and Genetic Algorithm.
CO4	Apply soft computing techniques for real-world problems

23EEXX06	EV Batteries & Battery Management System	3L-1T-0P	3 Credits

Course learning Objective:

1. To understand the operation of Battery Management Systems.
2. To understand the mathematical modeling of batteries.
3. To understand battery testing procedures.

Course content:

Unit-I: EV Batteries

Lead acid battery basics, Special characteristics of lead acid batteries, Battery life and maintenance, Battery charging, Summary. Nickel-based Batteries, Introduction, Nickel cadmium, Nickel metal hybrid batteries Sodium-based Batteries, Introduction, Sodium Sulphur batteries, Sodium metal chloride(Zebra) batteries Lithium Batteries, Introduction, the lithium polymer battery, charging requirements and charging standards.

Unit-II: Battery characteristics & parameters

Cells and Batteries, conversion of chemical energy to electrical energy, Battery Specifications: Variables to characterize battery operating conditions and Specifications to characterize battery nominal and maximum characteristics; Efficiency of batteries; Electrical parameters-Heat generation-Battery design-Performance criteria for Electric vehicles batteries-Vehicle propulsion factors-Power and energy requirements of batteries

Unit-III: Battery modeling

General approach to modelling batteries, simulation model of a rechargeable Li-ion battery, simulation model of are chargeable NiCd battery, Parameterization of the Ni Cd battery model, Simulation examples.

Unit-IV: Battery pack and battery management system

Selection of battery for EVs & HEVs, Traction Battery Pack design, Requirement of Battery Monitoring, Battery State of Charge Estimation methods, Battery Cell equalization problem, thermal control, protection interface, SOC Estimation, Energy & Power estimation, Battery thermal management system, Battery Management.

Unit-V: Battery testing

Chemical & structure material properties for cell safety and battery design, battery testing, limitations for transport and storage of cell sand batteries, Recycling, disposal and second use of batteries. Battery Leakage: gas generation in batteries, leakage path, leakage rates.

Unit-VI: Battery disposal & recycling

Mechanical stress and pressure tolerance of cells, safety vents, Explosions: Causes of battery explosions, explosive process, Thermal Runway: High discharge rates, Short circuits, charging and discharging. Environment and Human Health impact assessment of batteries, General recycling issues and drivers, Methods of recycling of EV batteries.

Learning Resources:

Text Books:

1. Ibrahim Dinçer, HalilS. Hamut and Nader Javani, Thermal Management of Electric Vehicle Battery Systems, John Wiley & Sons Ltd., 2016.

2. T R Crompton, Battery Reference Book 3rd Edition, Newnes-Reed Educational and Professional Publishing Ltd. 2000.

Reference books:

1. G. Pistoia, J. P. Wiaux, S. P. Wolsky, Used Battery Collection and Recycling, Elsevier, 2001
2. Guangjin Zhao, Reuse and Recycling of Lithium Ion Power Batteries, John Wiley & Sons. 2017.

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

CO1	Understand Battery management systems
CO2	Available recycling methods of batteries
CO3	Understand Characteristics of different batteries.
CO4	Understand SOC, and SOH estimation

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX07	**Fundamental of Electric and Hybrid Vehicles**	**3L: 1T: 0P**	**3 credits**

Course Content:

Unit-I: Introduction to EV&HEV:
Past, Present & Feature of EV, Current Major Issues, Recent Development Trends ,EV Concept, Key EV Technology, State-of-the Art EVs & HEVs, Comparison of EV Vs IC Engine.

Unit-II EV System:
EV Configuration: Fixed & variable gearing, single & multiple motor drive, In-wheel drives

Unit-III: EV Parameters:
Weight, size, force, energy & performance parameters.

Unit-IV: 4 EV Propulsion:
Electric Motor: Choice of electric propulsion system, block diagram of EV propulsion system, concept of EV Motors, single motor and multi-motor configurations, fixed &variable geared transmission, In-wheel motor configuration, classification of EV motors, Electric motors used in current vehicle applications, Recent EV Motors, Comparison of Electric Motors for EV applications

Unit-V: Required Power Electronics &Control:
Comparison of EV power devices, converters for EV chargers, soft-switching EV converters, comparison of hard-switching and soft-switching converter, three-phase voltage-fed resonance dc link inverter, Basics of Microcontroller& Control strategies

Unit-VI: HEV (Hybrid Electric Vehicle):
Configuration of HEV (Series, Parallel, Series-parallel &Complex), Power Flow control, Examples. Power flow control in all HEV configurations, Examples of HEV system Performance.

Learning Resources:
Text books:

1. C.C Chan, K.T Chau, Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRCPress,2003.

Reference books:

1. Mehrdad Ehsani, Yimi Gao,Sebastian E.Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRCPress, 2004.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Course outcomes: At the end of the course, the students will be able to

CO 1	Understand the models to describe hybrid vehicles and their performance.
CO 2	Understand the different possible ways of energy storage
CO 3	Understand the different strategies related to energy storage systems.
CO 4	Understand the difference between Electric and Hybrid Vehicles.

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX04	**POWER SYSTEM OPERATION AND CONTROL**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives:

1. To understand optimal dispatch of generation with and without losses.
2. To study the optimal scheduling of hydro thermal systems.
3. To study the optimal unit commitment problem.
4. To study the load frequency control for single area system with and without controllers
5. .To study the load frequency control for two area system with and without controllers
6. To understand the reactive power control and compensation of transmission lines.

UNIT–I:

Economic Operation of Power Systems

Optimal operation of Generators in Thermal power stations, – Heat rate curve – Cost Curve – Incremental fuel and Production costs – Input–output characteristics – Optimum generation allocation with line losses neglected – Optimum generation allocation including the effect of transmission line losses – Loss Coefficients – General transmission line loss formula.

UNIT–II:

Hydrothermal Scheduling

Optimal scheduling of Hydrothermal System**:** Hydroelectric power plant models – Scheduling problems – Short term hydrothermal scheduling problem.

UNIT–III:

Unit Commitment

Optimal unit commitment problem – Need for unit commitment – Constraints in unit commitment – Cost function formulation – Solution methods – Priority ordering – Dynamic programming.

UNIT–IV:

Load Frequency Control-I

Modeling of steam turbine – Generator – Mathematical modeling of speed governing system– Transfer function – Modeling of Hydro turbine –Necessity of keeping frequency constant – Definitions of Control area – Single area control system – Block diagram representation of an isolated power system – Steady state analysis – Dynamic response – Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation – Steady state response.

UNIT–V:

Load Frequency Control-II

Block diagram development of Load Frequency Control of two area system uncontrolled case and controlled case.Tie-line bias control. Load Frequency Control and Economic dispatch control

UNIT–VI:

Reactive Power Control

Overview of Reactive Power control – Reactive Power compensation in transmission systems Advantages and disadvantages of different types of compensating equipment for transmission

systems – Load compensation – Specifications of load compensator – Uncompensated and compensated transmission lines**:** Shunt and series compensation – Need for FACTS controllers.

Course Outcomes:

CO1.	Able to compute optimal scheduling of Generators.
CO2.	Able to understand hydrothermal scheduling.
CO3.	Understand the unit commitment problem.
CO4.	Able to understand importance of the frequency.
CO5.	Understand importance of PID controllers in single area and two area systems.
CO6.	Will understand reactive power control and compensation for transmission line.

Text Books:

1. Electric Energy systems Theory – by O.I.Elgerd, Tata McGraw–hill Publishing Company Ltd., Second edition.
2. Modern Power System Analysis – by I.J.Nagrath&D.P.Kothari Tata McGraw Hill Publishing Company Ltd, 2nd edition.

Reference Books:

1. Power System Analysis and Design by J.Duncan Glover and M.S.Sarma., Thompson, 3rdEdition.
2. Power System Analysis by Grainger and Stevenson, Tata McGraw Hill.
3. Power System Analysis by HadiSaadat – TMH Edition.
4. Power System stability & control, PrabhaKundur,TMH

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100 %

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX02	**Smart Grid Technology**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives:

1. This course mainly focuses on basic fundamentals of smart grid for its implementation in the existing power system network.
2. This course provides an overview of smart grid and its applications in potential sectors of Modern power systems.
3. It also provides detailed utility level analysis in terms of energy management, network analysis and operation of smart grids.
4. The course also explores issues in management, control, protection and monitoring of the grid with renewable energy source integration as well as in micro grids at remote locations.

Course Content:

Unit-I : Smart Grid Technology Overview (6 Hours)
Initial Overview of various smart grid measurement and communication technologies, smart grid protocols, Difference between conventional & smart grid, Architecture of Smart Grid, Smart Grid Initiative for Power Distribution Utility in India

Unit-II:IT Enablers for Smart Grid Technology (6 Hours)
Overview of Multi-agent System, Distributed Intelligence, Big Data Analysis, Cloud Computing, Software-Defined Networks (SDN)

Unit-III: Smart Grid Decision Support and operational technology (10 Hours)
Concepts of Visualization, Self-Healing, Congestion Management, Dynamic OPF, Security Assessment, Contingency Analysis, Dynamic State estimation, Stability Analysis, Intelligent Fault Management, Feeder Reconfiguration, Short Circuit Analysis, Topology Processing, Power Quality, Voltage VAR Control, advanced control of generators, improved FACTS devices

Unit-IV: Smart Analytics (8 Hours)
Computational Intelligence, Wide Area Monitoring and Control Techniques, Demand Response Management, Predictive Asset Management, Forecasting Techniques

Unit-V: New technology Integration (8 Hours)
Renewable Integration, Plug-in Electric Vehicle, Smart home and Smart City concepts, Cooperative grids

Unit-VI: Smart Grid Market and Economics (7 Hours)
Energy market overview, Role of System Operators, DSO, and TSO under the smart grid, Transactive Energy

Learning Resources:
Text Books

1. Lars T. Berger and Krzysztof Iniewski, “Smart Grid Applications, Communications, And Security,” Wiley, New Delhi, Aug 2015

2. Buchholz, Bernd M., Styczynski, Zbigniew, "Smart Grids – Fundamentals and Technologies in Electricity Networks", Springer, 2014
3. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, and Nick Jenkins, "Smart Grid: Technology And Applications," Wiley, New Delhi, Aug 2015.

Reference Books

1. James Momoh, "Smart Grid: Fundamentals of Design and Analysis," (I E E Power Engineering Series)– Wiley-Blackwell, Apr 2012
2. Takuro Sato, Daniel M. Kammen, Bin Duan, Martin Macuha, Zhenyu Zhou, and Jun Wu, "Smart Grid Standards: Specifications, Requirements, and Technologies," WileyBlackwell, Apr 2015.
3. Chen-Ching Liu, Stephen McArthur, Seung-Jae Lee, "Smart Grid Handbook", 3 Volume Set, Wiley, USA, 2016

Web Resources

1. https://nptel.ac.in/courses/108107113

Course outcomes: On successful completion of the course students will able to

CO 1	Summaries various aspects of the smart grid Technologies, Components, Architectures and Applications
CO 2	Study and compare modern communication infrastructure and justify the feasibility of the same for smart grid applications.
CO 3	An overview of smart grid and its applications in potential sectors of Modern power systems.
CO 4	Provides detailed utility level analysis in terms of energy management, network analysis and operation of smart grids.
CO 5	The course also explores issues in management, control, protection and monitoring of the grid with renewable energy source integration as well as in micro grids at remote locations.
CO 6	Provides overview of the Smart Grid Market and Economics

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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23EEXX01	**Electrical Distribution Systems**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives

1. To study different factors of Distribution system.
2. To study and design the substations and distribution systems.
3. To study the determination of voltage drop and power loss.
4. To study the distribution system protection and its coordination.
5. To study the effect of compensation on p.f improvement.
6. To study the effect of voltage control on distribution system.

Content:

UNIT – I

General Concepts: Introduction to distribution systems, Load modeling and characteristics – Coincidence factor – Contribution factor loss factor – Relationship between the load factor and loss factor – Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics.

UNIT – II

Substations: Location of substations: Rating of distribution substation – Service area within primary feeders – Benefits derived through optimal location of substations. Distribution Feeders Design Considerations of distribution feeders: Radial and loop types of primary feeders – Voltage levels – Feeder loading – Basic design practice of the secondary distribution system.

UNIT – III

System Analysis: Voltage drop and power–loss calculations: Derivation for voltage drop and power loss in lines – Manual methods of solution for radial networks – Three phase balanced primary lines.

UNIT – IV

Protection: Objectives of distribution system protection – Types of common faults and procedure for fault calculations – Protective devices: Principle of operation of fuses – Circuit reclosures – Line sectionalizes and circuit breakers.

Coordination: Coordination of protective devices: General coordination procedure – Residual current circuit breaker RCCB (Wikipedia).

UNIT – V

Compensation for Power Factor Improvement: Capacitive compensation for power–factor control – Different types of power capacitors – shunt and series capacitors – Effect of shunt capacitors (Fixed and switched) – Power factor correction – Capacitor allocation – Economic justification – Procedure to determine the best capacitor location.

UNIT – VI

Voltage Control: Voltage Control: Equipment for voltage control – Effect of series capacitors – Effect of AVB/AVR –Line drop compensation.

Course Outcomes

CO1.	Able to understand the various factors of distribution system.
CO2.	Able to design the substation and feeders.
CO3.	Able to determine the voltage drop and power loss
CO4.	Able to understand the protection and its coordination.
CO5.	Able to understand the effect of compensation on p.f improvement.
CO6.	Able to understand the effect of voltage, current distribution system performance.

Text Books:

1. "Electric Power Distribution system, Engineering" – by TuranGonen, McGraw–hill Book Company.

Reference Books:

1. Electrical Distribution Systems by Dale R.Patrick and Stephen W.Fardo, CRC press
2. Electric Power Distribution – by A.S. Pabla, Tata McGraw–hill Publishing company, 4th edition, 1997.
3. Electrical Power Distribution Systems by V.Kamaraju, Right Publishers.

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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23EEXX05	**Non-conventional Energy Sources**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives:

1. To familiarise with Global energy scenario
2. To learn about Solar PV and Thermal systems
3. To get introduced to Wind Enegy systems
4. To know about Bio-energy sources
5. To know about Ocean, Thermal Energy sources
6. To understand the Batteries and Super Capacitors

Course Content

Unit-I
Global & National energy scenarios, Forms & characteristics of renewable energy sources

Unit-II
Solar radiation, Photovoltaics technology, configurations and applications.Flat plate collectors, Solar concentrators, Thermal Applications of solar energy,

Unit-III
Wind characteristics, Geography and other concepts Resource assessment, Horizontal & vertical axis wind turbines, Electricity generation and water pumping.

Unit-IV
Energy from biomass, Energy storage-Thermochemical, Biochemical conversion to fuels, biogas and its applications.

Unit-V

Ocean Thermal Energy Conversion (OTEC), Geothermal, Tidal and Wave energies, Material aspects of Renewable energy technologies and systems

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Unit-VI: Battery basics, types Testing, performance of batteries ,Flywheels and super capacitor

Text Books:

1. Non Conventional Energy Sources by G.D Rai, Khanna Publications.

Web Resources :

1. Non-Conventional Energy Resources, IIT Madras, Dr. Prathap Haridoss https://nptel.ac.in/courses/121106014
2. Non-conventional energy systems, IISC Bangalore, Dr.L.Umanand https://nptel.ac.in/courses/108108078

Course outcomes: On successful completion of the course students will able to :

CO 1	understand the global energy scenario
CO 2	know about Solar PV and Thermal systems
CO 3	know about Wind Energy Systems
CO 4	understand Bio-energy sources
CO 5	know about Ocean, Geo thermal and other sources
CO 6	understand the working of Batteries and super capacitors

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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23EEXX16	**Computer Organization and Architecture**	**ESC**	**3L: 1T: 0P**	**4 credits**

Course Learning Objectives:

To expose the students to the following:

1. How Computer Systems work & the basicprinciples.
2. Instruction Level Architecture and InstructionExecution.
3. The current state of art in memory systemdesign.
4. How I/O devices are accessed and itsprinciples.
5. To impart the knowledge on microprogramming.

Course Content

Unit I– (10 hours)

Architecture of 8086 microprocessor, special functions of general purpose registers,8086 flag register and function of 8086 flags, pin diagram of 8086,minimum and maximum mode of 8086 configuration and timing diagrams.Addressing modes of 8086, Instruction sets of 8086.

Unit II (12 hours)

Introduction to MIPS architecture, MIPS Instruction Set Architecture, Procedures, Recursive Programs, Architecture Examples, Introduction to Assessing and Understanding Performance, CPU Performance and its Factors, Evaluating Performance, Benchmarks and the performance of recent

IntelProcessors.

Unit III – (12hours)
Introduction to Processor: Data path and Control, Logic design Conventions, Building a Data path, Simple Implementation scheme, Multi-cycle Implementation, Exceptions, Microprogramming: Simplifying Control Design, Introduction to Digital Design Using a Hardware Design Language.

Unit IV – (10hours)
Introduction to Pipelining, A pipelined Data path, Pipelined Control, Data Hazards and Forwarding, Data Hazards and Stalls, Branch Hazards, Exceptions, Advanced Pipelining.

Unit V – (8hours)
Introduction to Memory Hierarchy, The Basic of Caches, Measuring and Improving Cache Performance, Virtual Memory, Common Framework for Memory Hierarchies.

Unit VI (10hours)

Introduction to Storage, Networks and other Peripherals, Disk Storage and Dependability, Networks, Busses and other Connections between Processors, Memory and I/O Devices, Interfacing I/O Devices to the Processor, Memory and Operating System, I/O Performance Measures, Designing an I/O System.

Learning Resources Text Books

1. David A. Patterson and John L. Computer Organization and Design Morgan Kaufmann Publishers, 3rd Edition.

Web resources

1. 1. Prof AnshulKumar,NPTEL-
   .URL:http://nptel.ac.in/courses/106102062/

Course outcomes: At the end of the course, the student will be able to

1	Able to write recursive program in MIPS.
2	Able to construct cost effective computer system.
3	Able to differentiate different designs and organizations.
4	Able to handle design issues in the development of processor or other components that satisfies design requirements.

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX17	**Advanced Digital Signal Processing**	**3L: 1T: 0P**	**3 credits**

Course Learning Objectives

1. To understand multi-rate systems and differentwavelets.
2. To learn about both CWT andDWT.
3. To understand variants of the wavelet transform and itsimplementation

Course Content

Unit -I **(6 hours)**

Need for multi resolution / multi-scale analysis, time-frequency analysis and generation of wavelets

Unit-II **(8 hours)**

Piece-wise constant approximation-the Haar wavelet, dyadic multi resolution analysis (MRA), relating dyadic MRA to filter banks, elements of multi-rate systems, two-band filter bankdesign

Unit-III **(8 hours)**

Orthogonal and bi-orthogonal wavelets, Daubechies family of wavelets, Vanishing moments and regularity, Conjugate Quadrature Filter banks (CQF), Data compression- fingerprint compression standards JPEG-2000standards.

Unit-IV **(8 hours)**

The uncertainty principle and its implications: Gaussian function, the Gabor transform and its generalization in time, frequency. Continuous wavelet transform (CWT).

Unit-V **(8 hours)**

CWT to the DWT discretization, discretization of scale, discretization of translation, discretization of time, Going from piecewise linear to piecewise polynomial, the class of spline wavelets.

Unit-VI **(7 hours)**

Variants of the wavelet transform and its implementation structures, the wave packet transform, Computational efficiency in realizing filter banks-polyphase components, the lattice structure, the lifting scheme applications.

Learning resources

Text books

1. Howard L. Resnikoff, Raymond O.Wells, 'Wavelet analysis :The Scalable Structure ofInformation

Web resources

1. Prof V.M.Gadre,NPTEL- Advanced Digital SignalProcessing
   URL: http://nptel.ac.in/courses/ 117101001

Course outcomes: At the end of the course, the student will be able to

1	Know the analysis of discrete time signals.
2	Analyze multirate DSP systems.
3	Determine coefficients for perfect reproduction filter banks and wavelets.
4	Choose parameters to take a wavelet transform, and interpret and process the result.
5	To analyze the different wavelet transformation techniques
6	Apply the algorithms for wide area of recent applications

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXY18	**Artificial Neural Networks**	**3L: 0T: 0P**	**3 credits**

Course Objectives

1. Principles of neuro computing with artificial neuralnetworks.
2. Supervised and unsupervisedlearning.
3. Connectionistarchitectures.

Course content

Unit -I **(6 hours)**

Introduction to Artificial Neural Networks

Artificial Neura Networks and Applications, ANN usefulness and capabilities, Equivalent electrical model, Artificial Neural Model and Linear Regression, Gradient Descent Algorithm, Nonlinear activation units and learning mechanisms, Basic learning rules, Leaning Mechanisms(Hebbian, Competitive, Boltzmann), classifications of Synaptic modification.

Unit-II **(8 hours)**

Associative Memory and Dimensions

Stochastic learning algorithm, Characteristics of associative memory, Associative memory model, Matrix Memory, Condition for Perfect recall, Statistical aspects of learning, properties of regressive model, Neural measure of effectiveness, V.C dimension, Shattering, Importance of V.C dimensions.

Unit-III **(8 hours)**

Single layer perception, Gauss-process, Least Mean Square Algorithm, Convergence Consideration in LSM algorithm, Perceptron Convergence Theorem, Bayes classifier and Perceptron, Bayes classifierfor perceptron**.**

Unit-IV **(8 hours)**

Back propagation algorithm

Back propagation algorithm, practical consideration in back propagation algorithm, Modes of training, Solution of Non-Linearity separable problems using MLP, Heuristics for Back Propagation, Mean and Variance induced local field, Multi-Class classification using Multilayered perceptrons.

Unit-V **(7 hours)**

Radial Basis Function networks

Cover's Theorem, RBF networks, separability and interpolation, types of phases, RBF as ill-posed surface reconstruction, Regularization, Solution of regularization equation : greens function, Use of greens function in regularization networks, Generalized RBF, Comparison between MLP and RBF, Learning mechanisms in RBF.

Unit-VI **(8 hours)**

Introduction principle components and analysis

Dimensionality Reduction Using PCA, Types of transformation, Hebbian-Based principle component analysis, Generalized Hebbian Algorithm, Introduction to Self organizing maps, Essential process in the formation of self organizing maps, Cooperative and adaptive processes in SOM, 2-D lattice, Vector quantization using SOM, Optimum encoder and decoder.

Learning resources

Text Books

1. Laurene V. Fausett ,'Fundamentals of Neural Networks: Architectures, Algorithms and Applications', Pearson publications.

Reference Books

1. Sivanandam, 'Introduction to Neural Networks using MATLAB', Tata McGraw Hillpublications.

Web Resources

1. Prof.S.Sengupta,NPTEL-IIT Kharagpur, ' Neural Networks'. URL:http://nptel.ac.in/courses/117105084

Course Outcomes:

The students will be able to

CO1	Neuro computing with artificial neural networks widely used for addressing real-world problems such as classification, regression, pattern recognition, data mining, time-series modeling, etc..
CO2	Unsupervised learning is studied using Kohonen networks. Recurrent networks of the Hopfield type are briefly covered.
CO3	There are offered contemporary parameter training techniques for all these connectionist architectures
CO4	Program implementations of the studied neural networks are provided inMatlab, and applied to classification, regression and time seriesdata.

Assessment Method:

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXY19	**Bio Medical Signal Processing**	**3L: 0T: 0P**	**3 credits**

Course Objectives:

1. Fundamental tools that are used to describe, analyze and process biomedical signals.
2. Fundamental principles in the analysis and design of filters, power spectral density estimation and non-stationary signal processing techniques with applications to biomedical signals will betaught.

SYLLABUS:

Unit I – (6hours)

Human body as a system, Building blocks, Biomedical signal origin & dynamics. (EEG, EMGetc.)

Unit-II (8 hours)

Filtering for Removal of artifacts Statistical Preliminaries; Time domain filtering (Synchronized Averaging, Moving Average). Filtering for Removal of artifacts contd. Time domain filtering (Moving Average Filter to Integration, Derivative-based operator), Frequency Domain Filtering (NotchFilter)

Unit-III (8 hours)

Filtering for Removal of artifacts contd. Optimal Filtering: The Weiner Filter. Filtering for Removal of artifacts contd. Adaptive Filtering Selecting Appropriate Filter

Unit-IV (8 hours)

Event Detection Example events (viz. P, QRS and T wave in ECG) Derivative based Approaches for QRS Detection Pan Tompkins Algorithm for QRS Detection. Event Detection contd. Dicrotic Notch Detection Correlation Analysis of EEG Signal.

Unit-V (8 hours)

Waveform Analysis Illustrations of problem with case studies Morphological Analysis of ECG Correlation coefficient The Minimum phase correspondent and Signal Length. Waveform Analysis contd. Envelop Extraction Amplitude demodulation The Envelogram Analysis of activity Root Mean Square value Zero-crossing rate Turns Count, Form factor.

Unit-VI (7 hours)

Frequency-domain Analysis Periodogram. Frequency-domain Analysis Averaged Periodogram Blackman-Tukey Spectral Estimator Daniells Spectral Estimator Measures derived from PSD.

Web References

1. Prof.Sudipta Mukhopadhyay,NPTEL-IIT Kharagpur 'Biomedical signal processing', URL:https://nptel.ac.in/courses/108105101/

Course Outcomes

The students will be able to

CO 1	Analyze the design techniques involved for digital filters
CO 2	Identify the bio-signals

CO 3	Understand special techniques like Heart rate variability Analysis

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXY20	**Digital Image Processing**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives

1. Students should able to understand fundamental technologies for digital image compression, analysis andprocessing.
2. Student should able to learn necessity of digital image and reconstruction of digital image
3. Student should able to know how to transform the images by using image transformation techniques
4. Student should able to understand the need for image transforms and their image enhancement.
5. Students should able to know the colour image processing techniques and their image segmentationmethods.

Course Content

Unit -I **(7 hours)**

Introduction to Digital image Processing and Image Digitization

Need of Image processing, Applications, Introduction to Video Sequence processing, Image compression, Image representation, Steps in Digital Image processing, Need of digitization, Image as matrix of Numbers, Sampling, Signal Reconstruction from Samples, Convolution, 2D sampling, Image Quantization, Quantization error, Quantizer, Design. Relationships between pixels.

Unit -II **(8 hours)**

Basic Transformations and Image Interpolation

Translation, rotation, scaling, Camera Model and Image Geometry, Camera Calibration and Stereo Imaging, Stereo Image modeling, Interpolation and Resampling, B-spline interpolation Functions, Constant interpolation, Image Transformation, DCT Basis Images, Walsh Transform, HadamardTransform

Unit-III **(7 hours)**

Image Transforms

Image Transformation, Basis Images, Fourier Transformation, Discrete Cosine Transform, Walsh Transform, Hadamard Transform. K- L Transform.

Unit-IV **(7 hours)**

Image Enhancement and Image Restoration

Necessity of Image Enhancement, Spatial Domain Operations, Frequency domain operations, Power law transformation. Image Enhancement frequency. Image Restoration and Restoration techniques, Image Registration.

Unit-V **(8 hours)**

Colour Image Processing and Image Segmentation

Primary and Secondary Colours, Chromaticity diagram and its use, RGB color model, HIS color model, Conversation from one model to another, Pseudo Color Image processing, Colour and intensity modifications, Image Segmentation, Linking of edge points, Threshold Technique, Region basedSegmentation.

Unit-VI **(8 hours)**

Mathematical Morphology and Object Representation and Description. Morphological Image processing Techniques: Dilation, Erosion, Opening, Closing. Applications Hit or Miss Transform, Image under Standing Techniques, Boundary based Descriptions, Region based Descriptions, Recognition techniques: Using shape number, Feature based Techniques, Neural basedTechnique.

Learning Resources

Text books

1. Rafel C. Gonzalez and Richard E. woods, 'Digital Image Processing', Pearson publishers

Referencebooks

1. Fundamentals of Digital Image Processing Amit. K. Jain

Web Resources

1. Prof. P.K Biswas, NPTEL-IIT Kharagpur, URL:http://nptel.ac.in/courses

Course outcomes: At the end of the course, the student will be able to

CO 1	The course will cover techniques and tools for digital image processing, and finally also introduce image analysis techniques in the form of image segmentation.
CO 2	The course is primarily meant to develop on-hand experience in applying these tools to process these images. Hence the programming assignments form a key component of this course
CO 3	The students would be encouraged to develop the image processing toolsfrom scratch, rather than using any image processing library functions.
CO 4	Students will also get an opportunity to familiarize with Open CV image processing library.
CO 5	Emphasis will be to develop engineering skills and intuitive understanding of the tools used in Image Processing.
CO 6	Select feature extraction techniques for image analysis and recognition.

Assessment Method:

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXY21	**Estimation of Signals and Systems**	**3L: 0T: 0P**	**3 credits**

Course Objectives

1. Signal detection and estimation is the area of study that deals with the processing of information-bearingsignals.
2. Applications of the theory of signal detection and estimation are in many areas, such as communications, automatic control, radar/ sonar, speech and image processing and medical signalprocessing.
3. In general, detection and estimation applications involve making inferences from observations that are distorted or corrupted in somemanner.
4. Cast detection and estimation problems in a probabilistic framework in which unknown behavior is assumed to berandom.

Course Content

Unit I – (6hours)
Introduction, Probability Theory, Random Variables, Function of Random Variable Joint Density, Mean and Variance.

Unit-II (7 hours)
Random Vectors Random Processes, Random Processes and Linear Systems, Some Numerical Problems, Miscellaneous Topics on Random Process, Linear Signal Models.

Unit-III (8 hours)
Linear Mean Square Error Estimation, Auto Correlation and Power Spectrum Estimation- Transform Revisited Eigen Vectors/Values, The Concept of Innovation, Last Squares Estimation Optimal IIR Filters.

Unit-IV (8 hours)
Introduction to Adaptive Filters, State Estimation, Kalman Filter-Model and Derivation, Estimator Properties

Unit-V (8 hours)
The Time-Invariant Kalman Filter, Kalman Filter-Case Study, System identification Introductory Concepts, Linear Regression-Recursive Least Squares, Variants of LSE

Unit-VI (8 hours)
Least Square Estimation, Model Order Selection Residual Tests, Practical Issues in Identification, Estimation Problems in Instrumentation and Control Conclusion

Learning resources

Text Books

1. H. L. Van Trees, "Detection, Estimation and Modulation Theory: Part I, II and III", John Wiley, NY,1968.
2. H. V. Poor, "An Introduction to Signal Detection and Estimation", Springer, 2/e, 1998.

Reference Books

1. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", Prentice Hall PTR,1993.
2. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory", Prentice Hall PTR,1998.

Web resources

1. Prof S Mukhopadhyay,NPTEL- IIT Kharagpur, 'Estimation of signals and https://nptel.ac.in/courses/108105059/

Assessment Method:

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX23	**Medical Image analysis**	**3L: 0T: 0P**	**3 credits**

Course Learning objectives

1. To provide students with an overview of the computational and mathematical methods in medical image processing.
2. To learn medical image data analysis (CT, MRI, PET and Ultrasound).
3. To learn current methods used to enhance and extract useful information from medica limages.

Course content

Unit I **(6 hours)**

Introduction to Medical Image analysis

Medical Image analysis and overview

Unit-II **(6 hours)**

Imaging and Clustering

X ray and CT Imaging, Magnetic Resonance Imaging, Ultrasound Imaging, Optical Microscopy and Molecular Imaging, Texture in Medical Images, Region Growing and Clustering.

Unit-III **(6 hours)**

Image Segmentation

Random Growing and Clustering, Random Walks for Segmentation, Active Contours for Segmentation, Systematic Evaluation and Validation, Decision Trees for Segmentation and Classification, Random Forests for segmentation and Classification.

Unit IV **(10hours)**

Neural Networks for Segmentation

Simple neuron, Neural network formulation, Learning with error back propagation, Gradient checking and optimization.

Unit-V **(12 hours)**

Medical Image Analysis

Medical Image processing using MATLAB

Case study: Finding parasitic infections with MATLAB: Explore and manage a range of real- world image sets, Solve challenging image processing problems with user interfaces, Develop familiarity with simple to advanced image segmentation approaches, Classify parasitic infections using machine learning techniques

Unit-VI **(5 hours)**

Applications

Retinal Vessel Segmentation, Vessel Segmentation in Computed Tomography Scan of Lungs, Tissue Characterization in Ultra sound.

Learning Resources

Text books

1. Dougherty, 'Medical Image Processing', Springer, 2011.

Reference Books

1. K.D.Toennies,' *Guide to Medical Image Analysis'* ,Springer, 2012.
2. T. M. Deserno, 'Biomedical Image Processing', Springer,2011.
3. A. Criminisi, J. Shotton, 'Decision Forests for Computer Vision and Medical Image Analysis', Springer,2013.

Web resources

1. Prof. Debdoot Sheet,NPTEL- Medical Image Analysis http://nptel.ac.in/courses/108105091
2. URL:https://www.mathworks.com/videos/medical-imaging-workflows-with-matlab-81850.html
3. URL:https://www.mathworks.com/videos/medical-image-processing-with-matlab- 81890.html

Course outcomes: At the end of the course, the student will be able to

CO 1	Exposure to a variety of radiological diagnostic scenarios with examples
CO 2	Analyze medical image outputs of X-Ray, MRI scan, CT scan etc
CO 3	Analyze image segmentation mechanisms
CO 4	Application of specific image processing techniques for medical diagnosis
CO 5	Application of Neural networks for medical image analysis
CO 6	Application of MATLAB for medical image analysis

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEX24	**Pattern Recognition and applications**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives

1. To understand the mathematical approach for patternrecognition.
2. To apply neural networks for pattern recognition.
3. To learn to apply pattern recognition for resolving real time problems

Course content

Unit-I (7 hours)

Polynomial curve fitting The curse of dimensionality - Decision theory- Information theory - The beta distribution - Dirichlet distribution-Gaussian distribution The exponent family: Maximum likelihood and sufficient statistics -Non-parametric method: kernel- density estimators - Nearest neighbormethods.

Unit-II (8hours)

Linear models for regression and classification: Linear basis function models for regression -Bias variance decomposition-Bayesian linear regression - Discriminant functions- Principal ComponentAnalysis (PCA) - Probabilistic generative model - Probabilistic discriminative model.

Unit-III (8 hours)

Kernel methods: Dual representations-Constructing kernels-Radial basis function networks-Gaussian process-Maximum margin classifier (Support Vector Machine) Relevance Vector Machines-Kernel-PCA,Kernel-LDA.

Unit-IV (8 hours)

Mixture models: K-means clustering - Mixtures of Gaussian - Expectation-Maximization algorithm-Sequential models: Markov model, Hidden-Markov Model (HMM) - Linear Dynamical Systems (LDS).

Unit-V (8 hours)

Neural networks: Feed- forward Network functions-Network training - Error Back propagation - The Hessian Matrix - Regularization in Neural Network - Mixture density networks Bayesian NeuralNetworks

Unit-VI (6 hours)

Applications: Speech recognition, Character and handwriting recognition. Analysis of biological sequences

Learning Resources

Text Books

1. C.M.Bishop, 'Pattern recognition and machine learning',Springer,2006
2. J.I.Tou& R.C. Gonzalez, 'Pattern Recognition Priciples', Addsion Wesley Publishing company

Reference books

1. Richard O. Duda, Peter E. Hart and David G. Stork, "Pattern Classification", John Wiley & Sons,2001.
2. EarlGose, Richard Johsonbaugh and Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall,1999.

Web resources

1. Prof.P.K.Biswas, NPTEL- IIT Kharagpur, 'Patternrecognition ', URL: http://nptel.ac.in/courses/117105101

Course outcomes: At the end of the course, the student will be able to:

CO 1	summarize the various techniques involved in pattern recognition
CO 2	identify the suitable pattern recognition techniques for applications
CO 3	apply performance evaluation methods for pattern recognition, and critique comparison of techniques
CO 4	apply pattern recognition techniques to real-world problems such as document analysis and recognition.
CO 5	implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.
CO 6	summarize the artificial neural network based pattern recognition techniques

Assessment Method:

Assessment Tool	Weeklytests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXY25	**Analog IC Design**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives

1. To learn basics of negative feedback amplifiers and itscharacteristics
2. To learn broad coverage in the field that is relevant linear circuits using opamps.
3. Understand the applications ofop-amps
4. To learn the different noises present in transistors andresistors
5. To learn how to design single endedop-amps

Course Content

Unit I (8 hours)
Negative feedback systems and stability
Negative feedback amplifier using an integrator, Frequency and time domain behavior, Loop gain and its implications, Negative feedback amplifier realization, Finite DC gain, Increasing DC gain, Effect of multiple poles, Negative feedback systems with multiple poles and zeros in the forward path, Stability analysis using Nyquist criterion, Nyquist criterion, Loop gain- Bode plot and time domain interpretation, Significance of 60 degree phasemargin

Unit II (8 hours)
Opamp at the block level: Frequency compensation
Concept of the opamp for realizing negative feedback circuits, Realizing a multi stage opamp-frequency compensation-miller opamp, Realizing a multi stage opamp, feed forward compensated opamp, Opamp as a general block, unity gain compensation, non idealities- swing limits, slew rate, offset, dc negative feedback aroundop-amps

Unit III (8hours)
Opamp amplifiers
Amplifiers using Miller compensated opamp, Effect of input capacitance, gain bandwidth product, Transimpedance amplifier, lead-lag compensation, Inverting and non inverting amplifiers-CMRR and its importance

Unit IV (5hours)
Noise in resistors, MOS transistors and matching
Noise models, Noise calculations, Noise scaling, IC components and their models, Mismatch, Layout considerations. Body effect in basic amplifier stages, Frequency response of a common source amplifier

Unit V (8hours)
Single ended opamp design
Realizing a single stage opamp-diff pair, small signal ac analysis, Single stage opamp- mismatch and noise, Single stage opamp-telescopic cascode, Replica biasing a cascode, Single stage opamp-folded cascode, Two stage miller compensated opamp, Three stage opamp, CMRR of an opamp and opamp circuits.

Unit VI (8hours)
Fully differential opamp design

Fully differential opamps, Differential and common mode half circuits, common mode feedback, Fully differential miller compensated opamp-common mode feedback loop and its stability, Fully differential single stage opamp, Fully differential telescopic cascode opamp, Fully differential feed forward compensated opamp.

Learning Resources:

Text book

1. Behzad Razavi, 'Design of Analog CMOS Integrated Circuits',McGraw-Hill

Reference books

1. Jim Williams, Newnes *"Analog Circui*t Design: Art, Science and Personalities (EDN Series for Design Engineers) (Paperback),, Reprint edition,1991.
2. David Johns and Ken Martin *"Analog Integrated Circuit Design*, , John Wiley & Sons,1997.

Web Resource

1. Prof S Aniruddhan, NPTEL-IIT Madras, 'Analog IC Design', URL:https://nptel.ac.in/courses/108106105/
2. Prof Behzad Razavi, 'Lectureseries on Analog Electronics-2' URL:https://www.youtube.com/playlist?list=PLO4mxQzfcml_56XSGcA8ULO v7qEtZd0Hy

Course outcomes: At the end of the course, the student will be able to learn

CO 1	How to design negative feedback systems
CO 2	How to draw the frequency response of op amp.
CO 3	Design the applications of op amp.
CO 4	Identify different noises present in analog circuit design
CO 5	Design of single ended opamp
CO 6	Design of differential amplifier

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXY26	**Digital IC Design**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives

The objective of the course is to provide students with a basic understanding of the integrated circuit devices namely combinational and sequential circuits by using CMOS

Course Content

Unit -I (3 hours)

A Historical Perspective, Issues in Digital Integrated Circuit Design, Quality Metrics of a Digital Design, Cost of an Integrated Circuit, Functionality and Robustness, Performance, Power and Energy Consumption.

Unit -II (5hours)

Introduction, Interconnect Parameters Capacitance, Resistance, and Inductance, Capacitance, Resistance, Inductance, Electrical Wire Models, The Ideal Wire, The Lumped Model, The Lumped RC model, The Distributed RC Line, The Transmission Line

Unit -III (10hours)

Introduction, The Static CMOS Inverter An Intuitive Perspective, Evaluating the Robustness of the CMOS Inverter: The Static Behavior, Switching Threshold, Noise Margins, Performance of CMOS Inverter: The Dynamic Behavior, Computing the Capacitances, Propagation Delay: First-Order Analysis, Propagation Delay from a Design Perspective, Power, Energy, and Energy-Delay, Dynamic Power Consumption, Static Consumption

Unit -IV (8 hours)

Introduction, Static CMOS Design, Complementary CMOS, Rationed Logic, Pass- Transistor Logic, Dynamic CMOS Design , Dynamic Logic: Basic Principles, Speed and Power Dissipation of Dynamic Logic , Issues in Dynamic Design, Cascading Dynamic Gates, Perspectives, Designing Logic for Reduced Supply Voltages

Unit -V (10hours)

Introduction, Timing Metrics for Sequential Circuits, Classification of Memory Elements, Static Latches and Registers, The Bistability Principle, Multiplexer-Based Latches, Master- Slave Edge-Triggered Register, Low-Voltage Static Latches, Static SR Flip- Flops Writing Data by Pure Force, Dynamic Latches and Registers, Dynamic Transmission-Gate Edge- triggered Registers, C2MOS A Clock-Skew Insensitive Approach, True Single-Phase Clocked Register (TSPCR), Alternative Register Styles, Pulse Registers Sense-Amplifier Based, Registers , Pipelining: An approach to optimize sequential circuits, Latch- vs. Register-Based Pipelines, NORA-CMOS A Logic Style for Pipelined Structures, Non-Bistable Sequential Circuits

Unit VI (9hours)

Introduction, Memory Classification, Memory Architectures and Building Blocks, The Memory Core, Read-Only Memories Nonvolatile Read-Write Memories, Read-Write Memories (RAM), Contents-Addressable or Associative Memory (CAM), Memory Peripheral Circuitry, The Address Decoders, Sense Amplifiers Voltage References, Drivers/Buffers, Timing and Control, Memory Reliability and Yield, Signal-To-Noise Ratio, Memory yield, Power Dissipation in Memories, Sources of

Power Dissipation in Memories, Partitioning of the memory, Addressing the Active Power Dissipation.

Learning Resources

Text Books

1. Jan M. Rabaey ,AnanthaChandrakasan and Borivoje Nikolic *'Digital Integrated* - A Design Perspective (Second Edition)

Web Resources

1. URL: https://www.youtube.com/playlist?list=PLB3i9IKhwBX8EEkgSy0AjaRFCmY2g BiQc

Course outcomes: At the end of this course student will able to

CO 1	Understand the practical aspects of Digital IC Design
CO 2	Understand the concepts of Static and Dynamic CMOS logic design
CO 3	Understand the timing issues of design
CO 4	Analyse the power dissipation issues in circuits
CO 5	Optimize the design considering the concepts of pipelining
CO 6	Understand the concept of memory cell design at transistor level abstraction

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXY27	**Digital VLSI System Design**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives:

1. To learn how to formulate ASM charts for sequential and combinationalcircuits.
2. To learn how to design thememories
3. To learn pipelining and parallelism concepts of differentarchitectures
4. To learn how to design the DCTQprocessor.
5. To learn implementations using FPGAdevice

Course Content:

Unit -I (8 hours)

Algorithmic State Machines: Components of ASM Chart, ASM for Binary Multiplier, ASM for weighing machine, ASM for Bus Arbiter, Arithmetic Mean, Sort operation

Unit -II (6hours)

Design of Memories

On-Chip dual address ROM Design and Verilog implementation, Single Address ROM Design and Verilog implementation, On-Chip Dual RAM Design

Unit -III (8 hours)

Design of Arithmetic Circuits

Principle of pipelining, partitioning of a design, serial signed adder design, parallel signed adder design , parallel and pipelined multiplier design and Verilog implementations

Unit -IV (8 hours)

Design of a Discrete Cosine Transform and Quantization Processor

DCTQ processor block diagram, Signal description of DCTQ processor , Architecture of DCTQ processor, Verilog code for DCTQ Datapath and Control path, verification of DCTQ processor

Unit -V (10hours)

RT Level Design

Sequential Multiplier shift and add multiplication process , sequential multiplier design , multiplier testing, Von Neumann Computer Model-processor model specification, designing the adding CPU, design of data path and control path, testing adding CPU, CPU Design and Test- details of processorfunctionality.

Unit VI (5hours)
Hardware Implementations using FPGA and I/O Boards
FPGA board features, features of Digital Input/output board, Traffic light controller design and implementation on FPGA, Real Time clock design and implementation on FPGA, Projects for implementation on FPGA.

Learning resources

Text book:

1. S.Ramachandran, 'Digital VLSI SystemsDesign
2. Zainalabedin Navabi, 'Verilog Digital SystemDesign

Web Resources:

1. URL: http://nptel.ac.in/courses/117106092

Course outcomes: At the end of the course, the student will be able to learn

CO 1	Formulation of ASM charts for digital systems
CO 2	Demonstrate the computer memories and implementing on FPGA board
CO 3	Understanding the RTL guidelines in digital system design
CO 4	Design of DCTQ processor using FPGA
CO 5	FPGA implementation of memory systems
CO 6	Practical aspects involved in FPGA design of digital systems

Assessment Method

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23ECXY28	**Electronics Systems Packaging**	**3L: 1T: 0P**	**3 credits**

Course Learning objectives

1. Students shall learn about the packaging evaluations
2. Students shall learn about the current trends in packaging
3. Students shall learn about the electrical issues and routing techniques
4. Students shall learn about CAD tools and PCB fabrication techniques
5. Students shall learn about the design issues
6. Students shall learn about the thermal design considerations in the packaging

Course Content

Unit-I (6hours)

Introduction, history of semiconductors, Packaging aspects of handheld products, Case studies in applications, Wafer fabrication, inspection and testing, Wafer packaging, Packaging evolution; Chip connection choices, Wire bonding, TAB and flip-chip.

Unit-II (7 hours)

Introduction, Single chip packages or modules (SCM), Commonly used packages and advanced packages; Materials in packages, Advances packages (continued); Thermal mismatch in packages; Current trends in packaging, Multichip modules (MCM)-types; System in package (SIP);Packaging roadmaps; Hybrid circuits.

Unit-III (8 hours)

Electrical Issues- Resistive Parasitic, Capacitive and Inductive Parasitic, Layout guidelines and the Reflection problem, Interconnection. Introduction to DFM, DFR & DFT, Components of a CAD package and its highlights, Design Flow considerations, Beginning a circuit design with schematic work and component layout, examples of layout and routing; Technology file generation from CAD; DFM check list and design rules; Design for Reliability

Unit-IV (8hours)

Review of CAD output files for PCB fabrication; Photo plotting and mask generation, Process flow-chart, PWB substrates, Substrates continued, Video highlights; Surface preparation, Photo resist and application methods, UV exposure and developing, printing technologies for PWBs PWB etching; Resist stripping, Screen-printing technology, Through-hole manufacture process steps; Panel and pattern plating methods, Video

highlights on manufacturing,Solder mask for PWBs;Multilayer PWBs; Introduction to microvias, Microvia technology and Sequential build-up technology process flow for high- density interconnects, Conventional Vs HDI technologies; Flexible circuits; Tutorial session.

Unit-V (8hours)

SMD benefits, Design issues; Introduction to soldering, Reflow and Wave Soldering methods to attach SMDs, Solders; Wetting of solders; Flux and its properties, Defects in wave soldering, Vapour phase soldering, BGA soldering and Desoldering/ Repair, SMT failures, SMT failure library and Tin Whisker, Tin-lead and lead-free solders, Phase diagrams; Thermal profiles for reflow soldering; Lead-free alloys, Lead-free solder considerations; Green electronics; RoHS compliance and e-waste recycling issues.

Unit-VI (8 hours)

Thermal Design considerations in systems packaging, Introduction to embedded passives; Need for embedded passives; Design Library; Embedded resistor processes, Embedded capacitors, Processes for embedding capacitors; Case study examples; Summary of materials in packaging.

Learning resources

Textbooks

1. William D.Brown, 'Advanced Electronic Packaging', IEEE Press,1999.

Reference books

1. William Trimmer, 'Micromechanics and MEMS: Classic and Seminal Papers to 1990 ' by, IEEE Press, IEEE Number PC4390, ISBN 0-7803-1085-3, NewYork.

Web resources

1. Prof G V Mahesh, NPTEL-IISc Bangalore, 'An Introduction to Electronics Systems Packaging', URL:http://nptel.ac.in/syllabus/108108031/

Course outcomes: At the end of the course, the student will be able to

CO 1	Understand the evaluation of the packaging techniques
CO 2	Understand the underlying concepts in the current trends in the packaging
CO 3	Understand the underlying concepts in the electrical issues in the packaging
CO 4	Understand the underlying concepts in the PCB fabrication
CO 5	Understand the underlying concepts in the Design issues
CO 6	Understand the underlying concepts in the thermal issues in the packaging

23EEXX29	**Embedded System Software Testing**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives

1. Students shall learn about Embedded Systems software testing
2. Students shall learn about software testing methods
3. Students shall learn about software testing matrices
4. Students shall learn about Embedded Systems integration
5. Students shall learn about SCM activities
6. Students shall learn about Embedded Systems software testing tools

Course Content

Unit-I (8hours)
Introduction of embedded systems and software testing, Marketing drivers, Role of testing, Key process elements for embedded software testing, Typical life cycle phase, Embedded C environment, Embedded testing setup, Prerequisites for embedded system testing, Test case design and procedures, Test standards, Depicting levels of testing, Software life cycle, Embedded V model life cycle, Nested V model life cycle, Master test planning.

Unit-II (8 hours)
Dynamic testing, Dynamic testing types, Black box testing, White box testing, Coverage aspects, Equivalance partitioning, State transition testing, State transition fault categories, Model based testing, Grey box testing, Testing tools-life cycle, Test automation and techniques, Risk based testing.

Unit-III (8 hours)
Static testing, Static vs dynamic testing, Static analysis, Static analysis tools, Coding standards, Sample rule, Stack overflow, Program inspection walkthrough and reviews, Test metrics, Test metrics life cycle and types, Software testing metrics.

Unit-IV (8 hours)
Software integration goals and objectives, Top down integration and testing, Integration considerations, Integration strategy comparison, Bottom up testing, Layer integration, Client server integration, Collaboration integration, Integration testing environment, Generating test cases, Regression testing, Case diagram, Test case maintenance.

Unit-V (7 hours)
Depicting levels of testing, Configure management elements, SCM activities, SCM phases, Different types of test processes related to software remodel, Introduction to EST and fundamentals of testing.

Unit-VI (6 hours)
LDRA unit testing tool introduction, Static analysis tool by using C or C++, Target based testing, Level testing, Identification of test cases, Test line work flow.

Learning Resources Textbooks

1. Bart Broekman and Edwin Note boom, 'Testing Embedded Software', Addison- Wesley.

Web Resources

1. Seer Akademi, NPTEL -MoU, IIT Madras, 'Embedded software Testing', URL: http://nptel.ac.in/courses/117106112

Course outcomes: At the end of the course, the student will be able to

CO 1	Understand the embedded system software testing
CO 2	Understand the software testing methods
CO 3	Understand the software testing matrices
CO 4	Understand the embedded systems integration
CO 5	Understand the SCM activities
CO 6	Understand the embedded system software testing tools

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX30	**FPGA based System design**	**3L: 0T: 0P**	**3 credits**

Course Objectives

1. Getting to know how to make an idea of digital system using FPGA.
2. Exploring FPGA for different practical applications.

Course content

Unit-I (6 hours)
Introduction to FPGAs, difference b/w synthesizable and non-synthesizable constructs, learning different elegant Verilog styles and etc. and design of Digital clock on FPGA.

Unit-II (6 hours)
Image processing on FPGA: acquisition of image on to FPGA board, performing different simple image processing operations on FPGA.

Unit-III (12 hours)
Game Design: Various interconnections with FPGA i.e. Keyboard, UART communication, VGA and etc. How to create an animated picture on Display through FPGA and introduction to variousP-mods.

Unit-IV (6 hours)
CORDIC implementation: Learning how to implement CORDIC algorithm on FPGA and Discrete Fourier Transform, Fast Fourier Transform.

Unit-V (7 hours)
Machine learning Algorithms on FPGA: synthesizing machine learning algorithms using IEEE 754 floating point representation.

Unit-VI (8 hours)
Robotics Application: Replacing Arduino and RasPI with FPGA board for effective processing.

Learning resources
Textbooks
Reference books

1. FPGA Prototyping by Verilog examples: Xilinx Spartan 3 Version by Pong chu.

Course Outcomes:

CO1	Student will able to design digital systems independently on FPGA.
CO2	Student would be able to implement image processing, signal processing architectures on FPGA board.
CO3	Students would be able to implement game design algorithms along with audio, graphics integration.

CO4	Students would be able to implement machine learning algorithms and use them for robotics applications.

23EEXY31	**Low Power Circuits and Systems**	**3L: 1T: 0P**	**3 credits**

Course Content:

Unit-I (6 hours)
Basics of MOS circuits
MOS Transistor structure and device modeling , MOS Inverters, MOS Combinational Circuits

Unit-II (6 hours)
Sources of Power dissipation
Dynamic Power Dissipation, Short Circuit Power, Switching Power, Glitching Power, Static Power Dissipation, Degrees ofFreedom

Unit-III (8 hours)
Supply Voltage Scaling Approaches
Device feature size scaling, Multi-Vdd Circuits, Architectural level approaches: Parallelism, Pipelining, Voltage scaling using high-level transformations, Dynamic voltage scaling, PowerManagement

Unit-IV (10hours)
Low Complement Via Magnitude
Switched Capacitance Minimization Approaches Hardware Software Tradeoff, Bus Encoding, Architectural optimization, Clock Gating, Logicstyles s

Unit-V (8 hours)
Leakage Power minimization Approaches
Variable-threshold-voltage CMOS (VTCMOS) approach, Multi-threshold-voltage CMOS (MTCMOS) approach, Power gating, Transistor stacking, Dual-Vt assignment approach (DTCMOS)

Unit-VI (7 hours)
Special Topics
Adiabatic Switching Circuits, Battery-aware Synthesis, Variation tolerant design, CAD tools for low powersynthesis

Learning resources
Textbooks
1. Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers,1995.

Reference books
1. Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley- Interscience,2000.

Web resources
1. URL:http://nptel.ac.in/courses/106105034/

Assessment Method:

Assessment Tool	Weeklytests (Insemester)	Monthly tests (In semester)	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23EEXX32	**MEMS and Microsystems**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives:

1. Students shall learn about the Importance of Micro Electronics & Micro sensors and Materials used.
2. Student shall learn about the clean room technology.
3. Students shall learn about different fabrication steps
4. Students shall learn about the different micro deposition techniques
5. Students shall learn about the fabrication of discrete electronic components
6. Students shall learn about different applications of micro sensors.

Course Content

Unit-I (6 hours)
Introduction to Nano Technology & Nano Materials. Evaluation of Micro Electronics and Micro Sensors, Materials for Micro Electronics & Micro sensors, Electrical, Physical, Chemical, Optical and Thermal Properties of a materials used for Micro Electronics & Micro Sensors.

Unit-II (6 hours)
Silicon wafer manufacturing process, Wafer orientations, Electrical, physical, chemical, thermal and optical properties for different orientations. Clean room classifications, Clean room protocols.

Unit-III (8 hours)
Fabrication process flow: cleaning, oxidation, ion implantation, diffusion of atoms, patterning, different photo-resists, Mask Alignment, Lithography-types, etching-types.

UnitIV (7 hours)
Different deposition techniques: Spin coater, Sputtering unit, Thermal Evaporation, Atomic vapour deposition, LPCVD, CVD, Metallization, Wafer bonding.

Unit V (10hours)
Fabrication of MOS capacitor, BJT, FET, PMOS, NMOS and CMOS.

UnitVI (8 hours)
Micro Machining techniques, Different Micro sensors, Different applications of Micro Electronics & Micro Sensors.

Learning Resources

Textbooks

1. Stephen D. Senturia, '*Microsystem Design'Kluwer*',Academic Publishers, 2001

Web resources

1. Prof SantiramKal, NPTEL-IIT Kharagpur, 'MEMS and Microsystems' URL:https://nptel.ac.in/courses/117105082/
2. Prof Shantanu Bhattacharya, NPTEL-IIT Kanpur, ' BioMEMS and Microfluids', URL:http://nptel.ac.in/courses/112104181/

Course outcomes: At the end of the course, the student will be able to

CO 1	Understand about the importance of Micro Electronics
CO 2	Analyse the underlying fundamentals in Clean Room Protocols
CO 3	Understand the underlying fundamentals in Micro-fabrication procedures
CO 4	Understand the underlying fundamentals in Micro-fabrication procedures
CO 5	Apply the fabrication procedures for developing the discrete electronic components
CO 6	Analyse the different applications of Micro Electronics & Micro Sensors

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

23ECXY33	**System Verilog**	**3L: 0T: 0P**	**3 credits**

Course Learning objectives

1. Learn the important concepts in SOC/ASIC/VLSI design verificationflow
2. Be ready and qualified for a Verification job in semiconductorindustry
3. Be able to code, simulate and verify SystemVerilogTestbenches
4. Learn the System Verilog language for Functional Verificationusage

Content

Unit-I (8 hours)
Data types: Built-in data types, Fixed-Size and Dynamic arrays, Queues, Associated arrays, Linked list, Enumerated Data types, Constants, Strings, Nettypes

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Unit-II (8 hours)
Procedural statements and routines: Tasks, Functions and Void functions, Routine arguments, Local data storage and Time values.

Unit-III (7 hours)
Test Bench and Design, Interface construct, Stimulus timing, Top-Level scope, Module interactions, System verilog assertions, the FOUR PORT ATM Router, directed test for the LC3 fetchblock.

Unit-IV (8 hours)
OOP: class, objects, Static and Global Variables, Class routines, Public vs Local and Building test bench, inheritance, factory patterns, type casting and virtual methods, copying an object, callbacks.

Unit-V (7 hours)
Threads and inter process communication: working with threads, disabling threads, inter process communication, events, semaphores, mail boxes, building a test bench with threads andITC.

Unit-VI (7hours)
Virtual interfaces with ATM router, connecting to multiple design configurations, procedural code in an interface. Introduction to Verification, Verification Plan, Directed testing, Functional coverage, Layered Test bench, Maximum code reuse.

Learning resources

Text book/Reference books

1. Chris Spear, '*SystemVerilog for Verification*', Springer Publications 3rd edition.

Web resources

Ramdas Mozhikunnath M, 'SoC verification using Systemverilog
URL: https://www.udemy.com/soc-verification-systemverilog/

Assessment Method:

Assessment Tool	Weekly tests	Monthly tests	End Semester Test	Total
Weightage (%)	10%	30%	60%	100%

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Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

20EEXY34	**VLSI DSP**	**3L: 0T: 0P**	**3 credits**

Course Learning Objectives:

1. To make an in-depth study VLSI implementation of DSParchitecture.
2. To enable students to design VLSI system with high speed and lowpower.
3. To make the students to implement DSP algorithm in an optimizedmethod.

Course content:

Unit I (6hours)
Typical DSP Algorithms, DSP Application Demands and scaled CMOS Technologies, Representations of DSP algorithms, Dataflow graph representations, loop bound and iteration bound, iteration bound of Multirate data-flow graphs

Unit II (8hours)
Pipelining of FIR Digital Filters, Parallel processing, pipelining and parallel processing for low power, retiming techniques, Unfolding: algorithm, properties, critical path, applications
, Folding: transformation, register minimization in folding architectures, folding of multiratesystems

UnitIII (7hours)
Systolic array design methodology, FIR systolic arrays, selection of scheduling vector, matrix multiplication and 2D systolic array design, cook-toom algorithm, winograd algorithm, iterated convolution, cyclic convolution, design of fast algorithm by inspection

UnitIV (8 hours)
Parallel FIR filters, Discrete Cosine Transform and Inverse DCT, Parallel architectures for rank-order filters, pipeline interleaving in digital filters, pipelining in 1st order IIR Digital filters, pipelining in higher-order IIR digital filters, parallel processing for IIR filters, low- power IIR filters

Unit V (8hours)
Parallel multipliers, interleaved floor-plan and bit-plane-based digital filters, bit-serial multipliers, bit-serial filter design and implementation, canonic signed digit arithmetic, distributed arithmetic, redundant number representations, carry-free radix-2 addition and subtraction, hybrid radix-4 addition, data format conversion, redundant to non-redundant converter

UnitVI (8hours)
Synchronous pipelining and clocking styles, clock skew and clock distribution in bit-level pipelined VLSI Designs, wave pipelining, constraint space diagram and degree of wave pipelining, implementation of wave-pipelined systems.

Learning Resources

', Springer, 2004 1. U.Meyer-DSP with FPGA

Course Outcomes: At the end of the course, the student will be able to

CO 1	Understand the overview of DSP concepts.
CO 2	Implementing DSP architectures using VLSI algorithms
CO 3	Improve the speed of digital system through transformation technique.
CO 4	Improve the speed of digital system through transformation technique.
CO 5	Perform pipelining and parallel processing in FIR systems to achieve high speed and low power.

Rajiv Gandhi University of Knowledge Technologies - AP

Department of Electrical & Electronics Engineering

20EEXY35	**VLSI Physical Design**	**3L: 0T: 0P**	**3 credits**

COURSE OBJECTIVE:

1. Understand the concepts of Physical Design Process such as partitioning, Floor planning, Placement and Routing.
2. Discuss the concepts of design optimization algorithms and their application to physical design automation.
3. Understand the concepts of simulation and synthesis in VLSI Design Automation
4. Formulate CAD design problems using algorithmic methods

Course Content

Unit-I (8 hours)
Introduction, Design representations, various design styles, VLSI physical design automation, Partitioning, Floor planning and various floor planning algorithms, pin Assignment and Placement.

Unit-II (7 hours)
Grid routing, Global routing, detailed routing and clock design.

Unit-III (7 hours)
Clock network synthesis, Power and ground routing, Time closure concept and time driven placement.

Unit-IV (8 hours)
Time driven placement, Physical synthesis, Performance-Driven Design flow, various miscellaneous approaches to timing optimization. Interconnect modelling, Design rule check and Layoutcompaction.

Unit-V: (7 hours)
Testing of VLSI circuits, Fault modelling, Fault simulation, Test pattern generation, Design for testability, Boundary Scan standard,BIST.

Unit-VI: (8 hours)
Low power VLSI design, Techniques to reduce power, Gate level design for Low Power, other low power techniques, Algorithmic level Techniques for Low Power Design.

*As this is a Industry relavant course, the syllabus may vary as per the needs.

Learning resources

Text books

1. S.H. Gerez Algorithms for VLSI automation John Wiley,1998.

Reference books

1. S.M. Sait , H. Youssef, *"VLSI Physical Design Automation"*, World scientific, 1999.

Web resources

1. Prof Indrani Sengupta, NPTEL-IIT Kharagpur, 'VLSI Physical design'
   URL: https://nptel.ac.in/courses/106105161

Course outcomes:

CO1	Students are able to know how to place the blocks and how to partition the blocks while for designing the layout for IC.
CO2	Students are able to solve the performance issues in circuit layout.
CO3	Students are able to analyze physical design problems and Employ appropriate automation algorithms for partitioning, floor planning,placement and routing
CO4	Students are able to decompose large mapping problem into pieces, including logic optimization with partitioning, placement and routing
CO5	Students are able to analyze circuits using both analytical and CAD tools

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