Course Title: SIGNALS AND SYSTEMS			
Course Code	21EE51	Credits:4	CIE: 50
Number of Lecture Hours/Week	3hrs (Theory)+2hrs. (Tutorials)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:

1. Knowledge of basic Analog signals is needed
2. Knowledge of Laplace transformation, Solutions of Differential equations

Course Objectives:

1. To study Definitions classification and basic operation of signals.
2. To understand time-domain representation for LTI systems.
3. To know Fourier series representation.
4. To study Fourier and Z transformation and their applications.

Modules	Teaching Hours
Module I **Introduction:** Definitions of signal and system, classification of signals, basic operations on signals, elementary signals, and systems viewed as interconnections of operations, properties of systems.	**08 hrs**
Module II **Time Domain Representations for LTI System:** Convolution, impulse representation, properties of impulse response representation, differential and difference equation representations, and block diagrams representation.	**08 hrs**
Module III **Fourier Series Representation for Signals:** Introduction, Fourier representations for four signal classes, orthogonality of complex sinusoidal signals, DFTS representations, continuous-time –series representations.	**08 hrs**
Module IV **Fourier Transformations and Applications of Fourier Representations:** DTFT representations, properties of representations. Frequency response of LTI systems, solution, of differential and difference equation using system function, Fourier transform representations for periodic signals, sampling of continuous time signals and signal reconstruction.	**10 hrs**
Module V **Z-Transforms:** Introduction, Z- transform, properties of ROC, properties Z- transform, inverse transformation, analysis of LTI systems, transfer function, stability and causality, unilateral Z-transform and its application to difference equation.	**08 hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Reference Books:

1. Simon Haykin and Barry Van Veen, "Signal and Systems", John Willey and Sins, 2001. Reprint 2002.
2. Signal and Systems by Ganesh Rao and Satish Tonga. 3rd Edition, Sanguine Technical Publishers, 2005.

3. Signal and Systems by Uday kumar. Elite Publishers, 2004
4. Michel J Roberts, "Signal and Systems: Analysis through linear system", TMI, 2003.
5. Alan V.Oppenheim, Alan S Willsky and S. Hamid Nawab, "Signal and Systems", pearson Eduction Asia, 2nd Edition, 1997. Indian.

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)
16EE54	CO1	**Classify different continuous and discrete signals**
	CO2	**Illustrate the time domain representation for Linear Time Invariant systems**
	CO3	**Analyze the fourier series and fourier transformation for discrete and continuous signals**
	CO4	**Apply the fourier series and fourier transformation for LTI system**
	CO5	**Illustrate fourier transform and Z-transform**

Course Articulation Matrix for the Academic Year 2021-22

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	3									1	3		1
2	CO2	3	3	3									1	3		1
3	CO3	3	3	3									1	3	1	1
4	CO4	3	3	3	1								1	3	1	1
5	CO5	3	3	3									1	3		1
		3	**3**	**3**	**1**								**1**	**3**	1	1

Course Title: **MICROCONTROLLER**			
Course Code	21EE52	Credits:04	CIE: 50
Number of Lecture Hours/Week	3 hrs.(Theory) + 2hrs (Practical)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:

1. Knowledge of Digital Electronics subject is required
2. Knowledge of Signal and system subject is needed
3. Knowledge of Microprocessors and its applications.

Course Objectives:

1. To study architecture of 8051 family.
2. To understand about instruction and programming.
3. To know about different types of interrupts.
4. To study I/O port interfacing.
5. To understand interfacing of external memory and 8255.

Modules	**Teaching Hours**
Module I **Introduction:** Overview of 8051 family, Architecture, Addressing modes, Registers, External Memory. **Instructions and Programming**: Arithmetic, Logic, Single bit, Jump and Call instructions and Programming.	**09 Hours**
Module II **Interrupts:** Counters and Timers, 8051 Interrupts, Timer interrupts, External hardware interrupts, Serial communication interrupts and Interrupts priority and its Programming.	**09 Hours**
Module III **I/O Port Interfacing**: I/O programming, ADC, DAC, LCD, Stepper motor, Keyboard Interfacing.	**08 Hours**
Module IV **Interfacing to External Memory**: Semiconductor memory, Memory address decoding, Interface with External ROM, Data memory space.	**08 Hours**
Module V **Interfacing to the Program Peripheral Interface:** 8255 Modes, Interfacing and its programming. **Arm 32-Bit Microcontroller:** Thumb-2 technology and application of ARM, Architecture of ARM, various units of Architecture, debugging techniques, registers and interrupts.	**08 Hours**

Question paper pattern: Two questions from each module will be set. The student has to answer five full questions, selecting at least one full question from each module.

Reference Books:

1. Muhammad Ali Mazidi & Janice Gillespie Mazidi: 8051 Controller and Embedded Systems – Pearson Education, Second edition, 2008.
2. Kenneth . J. Ayala: The 8051 Microcontroller Architecture, Programming and Application, 2E, Pen Ram International, 1991.
3. Predko: Programming and Customizing the 8051 Microcontroller" TMH, 2008.
4. Raj Kamal: Microcontroller: Architecture, Programming Interfacing and Systems Design" Pearson Education,2009.
5. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM Systems Developer's Guides- Designing & Optimizing System Software", 2008, Elsevier

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	
21EE52	CO1	**Describe the architecture and operation of 8051 microcontroller**	
	CO2	**Apply the knowledge of instruction set & addressing modes for writing programs**	
	CO3	**Use of timer & Interrupts through programs**	
	CO4	**Discuss the different applications such as ADC, DAC, LCD & develop the programs for interfacing.**	
	CO5	**Experiment I/O and memory interfacing**	
	CO6	**Develop the program and interfacing of 8255**	

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3											1	3		
2	CO2	3	2										1	3	2	2
3	CO3	3		2									1	3	2	2
4	CO4	3		1									1	3	2	2
5	CO5	3											1	3	2	2
6	CO6	3											1	3	2	2
		3	**2**	**1.5**									**1**	**3**	2	2

Course Title: **POWER SYSTEM ANALYSIS AND STABILITY**			
Course Code	**21EE53**	Credits:03	CIE: 50
Number of Lecture Hours/Week	**2hrs. (Theory)** + 2hrs (Tutorial)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite: Knowledge of Transmission and Distribution

Knowledge of Electrical Machine is needed

Course Objectives:

1. To study power system network with its basic knowledge.
2. To analysis different types of faults and short circuit studies in power system network.
3. To Calculate balanced and unbalanced load in Power system network.
4. To understand the concept of stability in power system engineering

Modules	**Teaching Hours**
Module I **Representation of Power System Components**: Circuit models of transmission line, synchronous machines, transformer on load, single line diagram, calculation of per unit quantities and per unit impedance and reactance diagram, advantages of P.U system, change in base quantities.	**8Hrs**
Module II **Symmetrical Three Phase faults:** Short circuit on unloaded transmission line, short-circuit currents and the reactance of synchronous machines on no load and load condition, current oscillograms. Analysis of short circuit using Thevenin's theorem, Selection of Circuit Breakers.	**8Hrs**
Module III **Symmetrical Components**: Resolution of unbalanced phase into their symmetrical components & vice versa, phase shift of symmetrical components passing through star - delta transformer. Power invariance. Analysis of balanced and unbalanced load using balanced and unbalanced three phase supply. Sequence impedances, sequence networks of power system elements. (Alternator, transformer and transmission line) positive, negative and zero sequence networks of power system elements.	**8Hrs**

Module IV **Unsymmetrical Faults:** Single line to ground (L-G), line to line (L-L), Double line to Ground (L-L-G) faults on unloaded alternator with and without fault impedance. Unsymmetrical faults on a power system with and without fault impedance. Open conductor faults in power systems.	**9Hrs**
Module V **Stability Studies**: Rotor dynamics and the swing equation of synchronous machine, constant M and H of rotating machines, Power angle equation, Stability studies, steady state stability and pull out curve. Transient stability, dynamic stability, equal-area criterion of stability studies and its applications, factors affecting on stability.	**9Hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Reference Books:

1. I.J. Nagrath and D.P. Kothari, "Modern power system analysis", Tata Mcgraw hill, 2nd edition. 2003..
2. W.D. Stevenson," Elements of power system analysis", McGraw Hill Higher Education; 4th Revised edition (1 September 1982)
3. Power system analysis by hadi sadat, TMH. 3rd Edition, 2011.
4. Computer Aided PSA, GL Kusic, PHI.3rd Edition 2010
5. Power system Analysis and stability by Neelakantan. 2013 Edition.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	
21EE53	CO1	**Illustrate power system network with its basic knowledge**	
	CO2	**Identify the different types of faults in power system network.**	
	CO3	**Calculate power of balanced and unbalanced load**	
	CO4	**Analyze the short circuit studies in power system network**	
	CO5	**Examine the stability concept in power system engineering**	

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	1									2	3	2	1
2	CO2	3	3	1	1		2						2	3	2	2
3	CO3	3	3	3	1								2	3	2	2
4	CO4	3	3	3	1								2	3	2	2
5	CO5	3	3	1	1								2	3	2	2
		3	3	1.8	1		2						2	3	2	1.8

Course Title: **POWER ELECTRONICS**			
Course Code	21EE54	Credits: 03	CIE: 50
Number of Lecture Hours/Week	2hrs (Theory)+2(Tutorial)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:

1. Digital electronics
2. Knowledge of Electronic Circuit is needed

Course Objectives:

1. To study Power MOSFET's IGBT.
2. To understand Thyristors, GTOs and Commutation Techniques.
3. To know about AC Voltage Controllers & Controlled Rectifiers.
4. To understand the use and Application of DC Choppers.

Modules	Teaching Hours
Module I **Power MOSFETs & Insulated Gate Bipolar Transistors (IGBTs):** Power MOSFETs Junction Structure, Principle of Operation, Output Characteristics, Safe Operating Area (SOA), Gate Electrode Capacitance, Power MOSFET Switching Times. **Insulated Gate Bipolar Transistors (IGBTs) :**IGBTs compared with power MOSFETs and power BJT, Junction Structure, Principle of Working, Terminal Capacitances, Gate Drive Requirements, Switching Times.	**09 hrs**
Module II **Thyristors & The Gate Turn Off Thyristor (GTO):** Thyristors Characteristics, Two-Transistor model of Thyristor, Thyristor Turn-On Thyristor. Turn off , Series operation of Thyristors, Parallel operation of Thyristors, di/dt Protection, dv/dt Protection. The Gate Turn Off Thyristor (GTO), Junctions Structures of Symmetrical and Anode Short GTO. GTO Switching characteristics.	**08 hrs**

Module III **Commutation Techniques & AC Voltage Controllers:** Introduction, Natural commutation, Forced commutation, self commutation, impulse commutation. **AC Voltage Controllers:** Introduction, Principle of ON-OFF and Phase Control. Single-phase bidirectional controllers with resistive and inductive loads.	**08 hrs**
Module IV **Controlled Converters:** Introduction principle and operation of Phase controlled converter and operation. Single phase converters, Full converters. Three-phase full-wave converters. **PWM Inverters:** Introduction, principle of operation, performance parameters, single phase bridge inverters, voltage control of single phase inverters, Three phase inverter (120 and 180 degree conduction mode)	**09 hrs**
Module V **DC Choppers:** Introduction, principle of step-down and step-up chopper with R and R-L load, Performance parameters. Chopper classification.	**08 hrs**
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	
Reference Books: 1. Power Electronics, M.H. Rashid 3rd Edition, P.H.I. / Pearson, New Delhi, 2006 2. "Power Electronics –Converters, Applications and Design", Ned Mohan, Tore M. Undeland, and William P.Robins, Third Edition, John wjley and sons.1989 3. Power Electronics circuit, Devices and applications. Rashid PHI, Third Edition 2013 4. Joseph Vithayathil "Power Electronics Principles and Applications" (Edition 2010)	

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	
21EE54	CO1	**Illustrate the working of specified power electronic devices – MOSFET, IGBT, GTO, SCR. C3**	
	CO2	**Analyze natural and forced commutation techniques.**	
	CO3	**Assess AC voltage controllers at resistive and inductive loads.**	
	CO4	**Analyze controlled rectifier for single and three phase converters for resistive and inductive loads.**	
	CO5	**Analyze and categorize DC choppers.**	

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	1	2									1	3	3	1
2	CO2	3	1	2									1	3	3	1
3	CO3	3	1	2									1	3	3	1
4	CO4	3	3	2									1	3	3	1
5	CO5	3	3	2									1	3	3	1
		3	1.8	2									1	3	3	1

Course Title: **POWER ELECTRONICS LAB**			
Course Code	21EEL55	Credits:01	CIE: 50
Number of Lecture Hours/Week	2hrs (Practical)		SEE: 50
Total Number of Lecture Hours			SEE Hours: 03

Sl.No.	List of Experiments
1	Static characteristics of SCR.
2	Static characteristics of MOSFET
3	Static characteristics IGBT.
4	SCR turn-on circuit using synchronized UJT relaxation oscillator
5	SCR Digital triggering circuit for a single-phase controlled rectifier / A.C voltage controller.
6	Single-phase full-wave rectifier with R and R-L loads.
7	A.C. voltage controller using TRIAC and DIAC combination connected to R and R~L loads.
8	DC-Chopper with RL load.
9	Single phase converter R load.
10	3-ϕ controlled rectifier R Load
11.	Single phase Full bridge Inverter with R load.
12.	Three phase Full bridge inverter with R load.

Course outcomes: On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	
19EE56	CO1	**Describe static characteristics of power electronic devices.**	
	CO2	**Experiment to trigger SCR using UJT relaxation oscillator and Calculate the RMS o/p voltage of AC voltage controller.**	
	CO3	**Calculate the DC o/p voltage of chopper.**	
	CO4	**Calculate the average o/p voltage of 1-ϕ Controlled converter and inverter.**	
	CO5	**Calculate the average o/p voltage of 3 - ϕ Controlled converter and inverter.**	

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3			1					2			1	3	1	1
2	CO2	3			1					2			1	3	1	1
3	CO3	3			1					2			1	3	1	1
4	CO4	3			1					2			1	3	1	1
5	CO5	3			1					2			1	3	1	1
		3			1					2			1	3	1	1

Course Title: COMPUTER APPLICATIONS TO POWER SYSTEM		
Course Code	**21EE61**	**CIE: 50**
Number of Lecture Hours/Week	**02hrs.(Theory) + 02(Tutorial)**	**SEE: 50**
Total Number of Lecture Hours	**42**	**SEE Hours: 03**
	Credit:	**03**

Prerequisite:

1. Electrical Power Transmission and Distribution System.
2. Power System Stability and Analysis.

Course Objectives:

1. To Study the different methods of Admittance bus of power system networks.
2. To understand different types of buses and its analysis using load flow study.
3. To Study and analysis of transient stability systems.
4. To understand economic concept of power systems.
5. To Study of different voltage control method for power systems.

Modules	Teaching Hours
Module I **Formation of Y-Bus of a power system network by direct inspection method incidence matrices:** Element node incidence matrix, Bus incidence matrix, Primitive network in impedance & admittance form, primitive {y} matrix. Formation of Y-bus by singular transformation method, Algorithm for formation of bus impedance matrix [z] on single phase basis.	**08hrs**
Module II **Load flow studies:** Types of buses, operating constraints, Classification of system variables load flow equations, solution of load flow equations by Gauss-Seidel method, and Newton Raphson method, Acceleration of convergence LF solution by Fast-decoupled method. Comparison of LF methods, Representation of tap changing & phase shifting transformer.	**09hrs**
Module III **Transient Stability Study:** Swing equation representation of synchronous machine for transient stability studies, load representation network performance equation, solution techniques with flow charts. Transient stability solution by numerical solution of differential equations, modified Euler's method, Runge-Kutta 4th order method.	**08hrs**

Module IV **Economic Operation of Power Systems.** Performance curves, load sharing between the units within plants, load sharing between plants including transmission losses. Penalty factor, Derivation of transmission loss formula and loss coefficient, hydrothermal constraints.	**08hrs**
Module V **Automatic Generation & Voltage control:** Automatic load frequency control (ALFC) and Automatic voltage regulator (AVR), loop diagrams Automatic load frequency control for fly ball governing system Generator model. Load model, turbine model. governor model complete ALFC Block diagrams steady state and dynamic response of ALFC loops single area and two area block diagram representation.	**09hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Reference Books:

1. Stag and EI-Abiad, "computer methods in power system Analysis", McGraw Hill International Edition 1968.
2. M.A. Pai " Computer Techniques in power system", Tata McGraw Hill, 2nd Edition 2006.
3. Nagrath & Kothari, "Modern Power System Analysis", Tata McGraw Hill, 2nd Edition 2003.
4. Uma Rao, "Computer Techniques", Tata McGraw Hill.
5. L.P. Singh, "Advanced Power System and Dynamics", New Age International Pvt.Ltd, New Age International Pvt.Ltd, New Delhi 2001.
6. R.N. Dhar, "computer Aided Power System Operations & Analysis", TMH 1984.
7. Hadi sadat, "Power system Analysis", TMH, 2nd Edition, 12th Reprint 2007.
8. Elgerd, "Electric Energy Systems Theory", TMH, 1983.

Course outcomes:
On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
21EE61	**CO1**	Describing the Y-bus formation in power system network through matrices and inspection method.
	CO2	Calculation of Voltage magnitude and power in a power system network.
	CO3	Relate various load flow method in power system network.
	CO4	Analyse the transient stability and Economic operation of power systems.
	CO5	Construct the various model in power system network.

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3		2	1							1	3	1	1
2	CO2	3	3		2	1							1	3	2	1
3	CO3	3	3		2	1							1	3	2	1
4	CO4	3	3		2	1							1	3	2	1
5	CO5	3	3		2	1							1	3	2	1
		3	**3**		**2**	**1**							**1**	**3**	**2**	**1**

Course Title: **SWITCH GEAR AND PROTECTION**			
Course Code	21EE62	Credit: 04	CIE: 50
Number of Lecture Hours/Week	3 Hours (Theory) + 2 Hours (Practical)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Course Objectives:

- Switches, fuses, MCB and Lightning Arresters
- Functioning of circuit breaker
- Characteristics and functions of relays
- Apparatus protection

Modules	**Teaching Hours**
Module -I **Switches and Fuses:** Introduction, energy management of power system, definition of switchgear. Types of switches, Introduction to fuse, fuse law, cut-off characteristics, time current characteristics, fuse material, HRC fuse, Liquid fuse, application of fuse, MCB and MCCBs **Lightning Arresters:** Causes of over voltages, lightning, working principle of different types of lightning arresters and Shield wires.	**08 Hrs**
Module – II **Circuit Breakers:** Introduction, requirement, principle and operation of circuit breakers. Comparison between an isolator and circuit breaker, phenomenon, properties, initiation and maintenance of an arc, Slepian's theory and energy balance theory for Arc interruption. Restriking voltage, recovery voltage, Rate of rise of Restriking Voltage, DC circuit breaking, AC circuit breaking, current chopping, capacitance switching, resistance switching, Rating of circuit breakers.	**09 Hrs**
Module – III **Types of Circuit Breakers:** Air Circuit Breakers – Air break and Air blast circuit breakers, Oil circuit breakers – Single break, double break, minimum OCB, SF_6 breaker – Preparation of SF_6 gas, Puffer and non Puffer type of SF_6 breakers. Vacuum circuit breakers – principle of operation and constructional details. Advantages and disadvantages of different types of circuit breakers, comparison of different circuit breakers, Rating and selection of Circuit Breakers. **Testing of Circuit Breakers:** Unit testing, Synthetic testing, Substitution test, Compensation test and Capacitance test.	**08 Hours**
Module – IV **Protective Relaying:** Requirement of Protective Relaying, Zones of protection, primary and backup protection, Essential qualities of Protective Relaying, Classification of Protective Relays.	**09 Hrs**

Induction Type Relay: Non-directional and directional, over current relays, IDMT and Directional characteristics, Differential relay- Principle of operation, percentage differential relay, bias characteristics, distance relay – Three stepped distance protection, Impedance relay, Reactance relay , Mho relay, Buchholz relay, Microprocessor based over current relay – block diagram approach.	
Module- V **Protection Schemes:** Principles and need for protective schemes, Zones of Protection. **Transformer Protection:** Differential protection, differential relay with harmonic restraint, Inter turn faults. **Generator Protection:** Merz price protection, prime mover faults, stator and rotor faults, protection against abnormal conditions - unbalanced loading, loss of excitation, over speeding. **Bus bars and Transmission Line Protection:** Introduction, bus bar protection, frame leakage protection, differential protection, distance protection, three zones protection	**08 Hrs**
Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.	

Text Books:

1. Switchgear & Protection, Sunil S. Rao., Khanna Publishers, 13th Edition, 2008
2. Power System Protection & Switchgear. Badriram & Viswa Kharma, TMH, 1st Edition 2001.
3. Fundamentals of Power System protection, Y.G. Painthankar and S R Bhide, PHI, 2009
4. Power System Protection and Switchgear, B. Rabindranath and N. Chandra, New Age International (P) Ltd. 1st Edition 2011.

Reference Books:

1. Electrical Power Systems, C.L.Wadhwa, 6th Edition, New Age International(P) Ltd. 2010
2. A Course in Electrical Power, Soni Gupta & Bhatnagar, Dhanapatirai.
3. Electrical Power, Dr. S.L.Uppal, Khanna Publications.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	
21EE62	CO1	Discuss different types of protection devices used in power system: switches, fuses, MCB, Lightning Arresters	
	CO2	Describe the principles of circuit breaker	
	CO3	Describe different types of circuit breaker, Suggest suitability circuit breaker, testing of circuit breaker	
	CO4	Understand and analyze electromagnetic relays	

	CO5	Find the causes of abnormal operating conditions of the apparatus and system.	
	CO6	Discuss different types of protection devices used in power system: switches, fuses, MCB, Lightning Arresters	

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3					2						2	3	2	1
2	CO2	3					2						2	3	2	1
3	CO3	3					2						2	3	2	1
4	CO4	3					2						2	3	2	1
5	CO5	3					2						2	3	2	1
		3					2						2	3	2	1

Course Title: **SIGNALS AND SYSTEMS**			
Course Code	21EE64X	Credits:03	CIE: 50
Number of Lecture Hours/Week	2hrs (Theory)+2hrs. (Tutorials)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite: 1. Knowledge of basic Analog signals is needed

2. Knowledge of Laplace transformation, Solutions of Differential equations

Course Objectives

5. To study Definitions classification and basic operation of signals.
6. To understand time-domain representation for LTI systems.
7. To know Fourier series representation.
8. To study Fourier and Z transformation and their applications.

Modules	**Teaching Hours**
Module I **Introduction:** Definitions of signal and system, classification of signals, basic operations on signals, elementary signals, and systems viewed as interconnections of operations, properties of systems.	**08 hrs**
Module II **Time Domain Representations for LTI System:** Convolution, impulse representation, properties of impulse response representation, differential and difference equation representations, and block diagrams representation.	**08 hrs**
Module III **Fourier Series Representation for Signals:** Introduction, Fourier representations for four signal classes, orthogonality of complex sinusoidal signals, DFTS representations, continuous-time –series representations	**08 hrs**
Module IV **Fourier Transformations and Applications of Fourier Representations:** DTFT representations, properties of representations. Frequency response of LTI systems, solution, of differential and difference equation using system function, Fourier transform representations for periodic signals, sampling of continuous time signals and signal reconstruction.	**10 hrs**

Module V	
Z-Transforms: Introduction, Z- transform, properties of ROC, properties Z-transform, inverse transformation, analysis of LTI systems, transfer function, stability and causality, unilateral Z-transform and its application to difference equation.	**08 hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Reference Books:

1. Simon Haykin and Barry Van Veen, "Signal and Systems", John Willey and Sins, 2001. Reprint 2002.
2. Signal and Systems by Ganesh Rao and Satish Tonga. 3rd Edition, Sanguine Technical Publishers, 2005.
3. Signal and Systems by Uday kumar. Elite Publishers, 2004
4. Michel J Roberts, "Signal and Systems: Analysis through linear system", TMI, 2003.
5. Alan V.Oppenheim, Alan S Willsky and S. Hamid Nawab, "Signal and Systems", pearson Eduction Asia, 2nd Edition, 1997. Indian.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)	Blooms Level
21EE64X	**CO1**	**Define and classify different types of signals**	**C1**
	CO2	**Interpret the time domain representation for LTI systems**	**C2**
	CO3	**Analyze the Fourier series and Fourier transformation for discrete and continuous signals**	**C4**
	CO4	**Apply the Fourier series and Fourier transformation for LTI system**	**C4**
	CO5	**Illustrate Fourier transform and Z-transform**	**C2**

Control Systems		
Subject code:22EE641	**Credits:04**	**Total hours:42**
CIE:50 marks	**SEE:50 Marks**	**SEE:03hrs**
Hours/week:3hrs.(Theory)+ 2hrs.(Practical) Credits:04		

Objectives of overall learning of the subject:

1. To study open –loop and closed –loop control system
2. To understand mathematical modelling of system.
3. To study the block diagram and signal flow graph reduction techniques.
4. To know and study time-response control systems and stability analysis of control system.
5. To understand frequency response and root locus analysis of control systems.
6. To understand the state variable and analysis.

MODULE -I

Physical Systems modelling:-Basic definitions of control systems, requirements of control systems, classification of control systems, and comparison of open loop and closed loop systems. Effect of feedback on closed loop systems. Modelling of basic mechanical & electrical components, modelling of mechanical, electrical and electromechanical systems using Laplace transform and differential equations, Analogous systems.

To Study the MATLAB Package for simulation of control system design 08 hrs

MODULE -II

Block Diagram Reduction Techniques: Block diagram representations, development of block diagram, reduction techniques to obtain over all transfer function using Block diagram Algebra. Signal flow graph and its properties, Mason's gain formula and its applications.

To Reduce Linear Systems Block Diagram Using Series, Parallel And Feedback Configuration using MATLAB 08 hrs

MODULE -III

Time Response & Stability Analysis: Time response, transient and steady state response of first order and second order systems for unit step input, Time domain specifications for second order systems. Classification of stability, BIBO stability, R-H criterion for stability Analysis and its special cases.

To verify the output response of a Second Order System using RLC circuit. 08 hrs

MODULE –IV

Root Locus & Frequency Domain Analysis: Root Locus, General rules to construction of root locus diagram, stability analysis using root locus. Frequency domain specifications, co-relation between time – domain & frequency domain specifications, Bode plot, Stability analysis. Polar plot, Nyquist stability, Nyquist plot, stability Analysis.

To analyze frequency response of a system by plotting Root locus, Bode plot and Nyquist plot using MATLAB software. 09 hrs

MODULE –V

State variable Analysis: Concepts of state variables, State space model, Diagonalization of State Matrix, Solution of state equations, Eigen values and Stability Analysis, Concept of controllability and observability. Difference Equations of time domain system. State-space models of linear discrete-time systems, Stability of linear discrete-time systems.

To develop state space model for a transfer function using MATLAB 09 hrs

Question Paper Pattern: Answer five full Questions selecting one full question from each module.

Course Out comes: At the end of the course student will able to

CO1: Explain basic terminologies of control system & mathematical modeling. C2
CO2: Analyze block diagram and signal flow graphs reduction techniques.C4
CO3: Use stability and time response analysis.C2
CO4: Explain Root Locus, analysis frequency response, frequency domain stability. C5
CO5: Explain basic state variables and state space models. C2

Text/Reference books:

1. Control system Engg, I.J. Nagrath & M Gopal , 5th edition New-Age Publications.

2. Control Engg: Theory and Practice: B N Bandyopadhaya, PHI Publications.

3. Control systems: Ashfaq hussain and Haroon Ashfaq, Dhanpat Rai and co.

4. Automatic control systems B.C. KVO PHI publications VII edition.

5. Control system Engg palani Mcaraw hill publications.

6. A Text books of Automatic control system Engg , Dr. N.K Joain, Dhanpat rai & co.

7. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.

8. K. Ogata, “Modern Control Engineering”, Prentice Hall, 1991.

Course Code	**21EEL66**	CIE: 50
Number of Lecture Hours/Week	**2hrs.(Theory)** **Credits: 01**	SEE: 50
Total Number of Lecture Hours	42	SEE Hours: 03

Modules	**Teaching Hours**
MATLAB 1. MATLAB fundamentals, matrices, Vectors, matrix and array operations. 2. Using built in functions, saving and loading data, script files. 3. Function files, language specific features much as loops, branches and control flow.	
Power system simulation using MATLAB, software packages and C++ 1. i) Y-Bus formation for systems with and without mutual coupling, by singular transformation and inspection method. ii) Determination of Bus currents, bus power & line flows for a specified system voltage bus profile. 2. ABCD parameters i) Formation for symmetric π/T configuration ii) Verification of AD-BC=1 III) Determination of efficiency and regulation 3. Determination of power angle diagrams for salient and nonsalient pole synchronous machines, reluctance power, excitation emf and regulation. 4. To determine fault currents and voltages in a single transmission line system with star-delta transformers, at a specified location for SLGF, DLGF, and LLF. 5. To determine fault curve i) swing curve ii) critical clearing time for a single machine connected to infinite bus through a pair of identical transmission lines. for a 3-phase on one of the lines for variation of inertia constant/line parameters/fault location/prefault electrical output. 6. Load flow analysis for a 3 Bus system using Gauss Seidal method for at least 3 iterations (Y-bus to be given as data) 7. Formation of jacobian for a system not exceeding 4 buses (no PV buses) in polar co-ordinates.	

8. For a given power system, computation of Jacobian to conduct load flow analysis using Newton Raphson method (no PV Buses) 9. Optimal generator scheduling for thermal power plants.	

Reference Books:

1. Rudrapratap, " Matlab getting started with MATLAB", Oxford University press.

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO #	Course Outcome (CO)
21EEL66	**CO1**	**Describe Power System tools of MATLAB, determine Y bus by using inspection and singular transformation.**
	CO2	**Determination of Bus Currents, Bus power and line flows for a specified power system networks.**
	CO3	**Determination of power angle diagrams for synchronous machines, find fault currents and voltages in a single transmission line system with star delta transformers.**
	CO4	**Load flow analysis for a power system network by using Gauss Seidal, Newton Raphson and fast decoupled load flow studies**
	CO5	**Determine optimal generator scheduling for thermal power plants**

Course Articulation Matrix for the Academic Year 2022-23

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3	3	3	1	1				2			1	3	2	2
2	CO2	3	3	3	1	1				2			1	3	2	2
3	CO3	3	3	3	1	1				2			1	3	2	2
4	CO4	3	3	3	1	1				2			1	3	2	2
5	CO5	3	3	3	1	1				2			1	3	2	2
		3	**3**	**3**	**1**	**1**				**2**			**1**	**3**	**2**	**2**

Course Title: **OPERATIONAL AMPLIFIERS AND LINEAR IC'S**			
Course Code	21EE642	Credits:03	CIE: 50
Number of Lecture Hours/Week	2hrs (Theory) + 2 (Tutorials)		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite: Knowledge of Analog and digital electronics is required.

Course Objectives:

1. To study op-amp & AC Amplifiers
2. To know about Op-Amp Frequency Response and Compensation
3. To understand about Signal Processing Circuits Op-amp Nonlinear Circuits.
4. To study Multivibrator & Signal Generator.
5. To study Active Filter & Voltage Regulators.

Modules	Teaching Hours
Module I **Basics of OP-amps and AC Amplifiers:** Basics of op-amp (Introduction, Block diagram & Characteristics), capacitor coupled voltage follower, High Zinc Capacitor coupled voltage follower, capacitor coupled Non-inverting amplifier, High Zinc capacitor coupled Non-inverting amplifier, Capacitor coupled inverting amplifier, setting upper cutoff frequency, capacitor coupled Difference amplifier, use of single polarity supply.	**9 Hrs**
Module II **Op-amps Frequency Response and Compensation:** Op-amp circuit stability, frequency and phase response, frequency compensating methods, op-amp circuit bandwidth, slew rate effects, stray capacitance effects, load capacitance effects, circuit stability precautions.	**8 Hrs**
Module III **Signal Processing Circuits and Op-amps Nonlinear Circuits :** Precision half wave and full wave rectifiers, limiting circuits, clamping circuits, peak detectors, Sample and Hold circuit, Crossing detectors, Inverting Schmitt trigger circuit, Non- inverting Schmitt circuits.	**8 Hrs**
Module IV **Multivibrator & Signal generator:** Astable multivibrator, Monostable multivibrator. Triangular/Rectangular wave generator, waveform generator design, phase shift oscillator, oscillator amplitude stabilization, Wein bridge oscillator, amplitude stabilization.	**8 Hrs**

Module V **Active filters & DC Voltage regulators:** First and second order, high pass , low pass, Band pass and Band stop filters. Basics of Voltage regulator, voltage follower regulator, adjustable o/p regulator, precision voltage regulator, IC LM723.	**9 Hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Reference Books:

1. Operational Amplifiers and Linear IC's by David A. Bell, PHI, Second Edition, 2008
2. Operational Amplifiers and Linear IC's by Ramakanth PHI Pearson 4th Edition, 2004
3. Linear integrated circuits by Roy Choudary, New Age International second edition, 2004.
4. Operational Amplifiers with linear integrated circuit by Stanley William D, Pearson Education, Fourth Edition, 2009.

Course outcomes: On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	
18EE631	CO1	**Describe the basics of Op-Amps**	
	CO2	**Calculate the frequency response of Op-Amps and Identify compensation methods of op-amp**	
	CO3	**Illustrate different types of signal processing circuit and Non-linear circuits**	
	CO4	**Design different types of multivibrator and signal generators**	
	CO5	**Identify and Illustrate the active filters and DC voltage regulators**	

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3											1	3		1
2	CO2	3		1									1	3	2	1
3	CO3	3	2										1	3	2	1
4	CO4	3	3										1	3	2	1
5	CO5	3	1										1	3	2	1
		3	**2**	**1**									**1**	**3**	**2**	**1**

Course Title: Reactive Power Management			
Course Code	21EE643	Credits:03	CIE: 50
Number of Lecture Hours/Week	**2Hrs (Theory) + 2(Tutorial)**		SEE: 50
Total Number of Lecture Hours	42		SEE Hours: 03

Prerequisite:

Course Objectives:

Modules	Teaching Hours
Module-I Load Compensation: Objectives and specifications, reactive power characteristics, inductive and capacitive approximate biasing, Load compensator as a voltage regulator, phase balancing and power factor correction of unsymmetrical loads, examples. (08 hours)	**08 Hrs**
Module-II Steady – State Reactive Power Compensation in Transmission System: Uncompensated line, types of compensation, Passive shunt and series and dynamic shunt compensation, examples Transient state reactive power compensation in transmission systems: Characteristic time periods, passive shunt compensation, static compensations, series capacitor compensation, compensation using synchronous condensers, examples.	**09 Hrs**
Module-III Reactive Power Coordination: Objective, Mathematical modeling, Operation planning, transmission benefits, Basic concepts of quality of power supply, disturbances, steady – state variations, effects of under voltages, frequency, Harmonics, radio frequency and electromagnetic interferences.	**08 Hrs**
Module-IV Demand Side Management: Load patterns, basic methods load shaping, power tariffs, KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels. Distribution side Reactive power Management: System losses, loss reduction methods, examples, Reactive power planning, objectives, Economics Planning capacitor placement, retrofitting of capacitor banks.	**09 Hrs**
Module-V User Side Reactive Power Management: KVAR requirements for domestic appliances, Purpose of using capacitors, selection of capacitors, deciding factors, types of available capacitor, characteristics and Limitations. Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems, reactive power control requirements, distribution transformers, Electric arc furnaces, basic operations, furnaces transformer, filter requirements, remedial measures, power factor of an arc furnace.	**08 Hrs**

Question paper pattern: Total ten questions will be asked. Two from each module. The student has to answer five questions, selecting at least one from each module.

Text Books:

01. Reactive power control in Electric power systems by T.J.E. Miller, John Wiley and sons, 1982.

02. Reactive power Management by D. M. Tagare, Tata McGraw Hill, 2004.

Reference Books:

01. Reactive Power Compensation: A Practical Guide, Wolfgang Hofmann, Jurgen Schlabbach, Wolfgang Just, Wiely publication 2012.

02. Reactive Power Compensation, Dr. Hidaia Mahmood Alassouli, Notion Press, 2020

Course outcomes:

On completion of the course, the student will have the ability to:

Course Code	CO	Course Outcome (CO)	Blooms Level
21EE643	CO1	Distinguish the importance of load compensation in symmetrical as well as unsymmetrical loads	
	CO2	Observe various compensation methods in transmission lines	
	CO3	Construct model for reactive power coordination	
	CO4	Distinguish demand side reactive power management & user side reactive power management	
	CO5		

S.No.	PO CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
1	CO1	3		2												
2	CO2	3		2	3											
3	CO3	3	3	3												
4	CO4	3	3										3			
5	CO5															