SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Engineering & Technology

T.E. (Electrical Engineering)

Choice Based Credit System Syllabus Structure of T. E. Electrical Engineering W.E.F. 2018-2019

Semester I

Course Code	***Theory Course Name***	***Hrs./week***			***Credits***	***Examination Scheme***			
		L	***T***	***P***		***ISE***	***ESE***	***ICA***	***Total***
EL 311	Power System Analysis	4	-	-	4	30	70	-	100
EL 312	Control System-I	4	-	-	4	30	70	-	100
EL 313	Microprocessor and Microcontroller	4	-	-	4	30	70	-	100
EL 314	Engineering Economics and Management	4	1	-	5	30	70	25	125
EL 315	Electromagnetic Engineering	4	1	-	5	30	70	25	125
SLH31	Self-Learning Module-I			-	2		50		50
Sub Total		20	2	-	24	150	400	50	600
Laboratory Course Name									
							ESE		
							POE	OE	
EL311	Power System Analysis	-	-	2	1	-	-	25	25	50
EL312	Control System-I	-	-	2	1	-	-	25	25	50
EL313	Microprocessor and Microcontroller	-	-	2	1	-	50	-	25	75
EL316	Electrical Workshop	-	-	2	1	-	-	-	25	25
Sub Total		-	-	8	4	-	100		100	200
Grand Total		**20**	**2**	**8**	**28**	**150**	**500**		**150**	**800**

- *Abbreviations: L - Lectures, P –Practical, T - Tutorial, ISE - In semester Exam, ESE - End Semester Exam, ICA - Internal Continuous Assessment, ESE - University Examination (Theory &/ POE &/Oral examination)*

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Engineering & Technology

T.E. (Electrical Engineering)

Choice Based Credit System Structure of T.E. Electrical Engineering W.E.F. 2018-2019

Semester II

Course Code	***Theory Course Name***	***Hrs./week***			***Credits***	***Examination Scheme***			
		L	***T***	***P***		***ISE***	***ESE***	***ICA***	***Total***
EL 321	Electrical Utilization	4	1	-	5	30	70	25	125
EL 322	Power Electronics	4	-	-	4	30	70	-	100
EL 323	Control System-II	4	-	-	4	30	70	-	100
EL 324	Signals and Systems	4	1	-	5	30	70	25	125
EL 325	Electrical Machine Design	4	-	-	4	30	70	-	100
EL 326	Self-Learning Module-II	-	-	-	2	--	50	-	50
Sub Total		20	2	-	24	150	400	50	600
Laboratory Course Name									
							ESE		
							POE	OE	
EL 322	Power Electronics	-	-	2	1	-	50	-	25	75
EL 323	Control System-II	-	-	2	1	-	-	-	25	25
EL 325	Electrical Machine Design	-	-	2	1	-	--	25	25	50
EL 327	Mini Hardware Project	-	-	2	1	-		25	25	50
Sub Total		-	-	8	4	-	100	100		200
Grand Total		**20**	**2**	**8**	**28**	**150**	**500**	**150**		**800**

- *Abbreviations: L - Lectures, P –Practical, T - Tutorial, ISE - In Semester Exam, ESE - End Semester Exam, ICA - Internal Continuous Assessment, ESE - University Examination (Theory &/ POE &/Oral examination)*

Self-Learning Module-II

1. Special Purpose Machines
2. Electrical Safety
3. Solar Photovoltaic System Design & Installation
4. Instrumentation Process Control & Robotics

Note –

- Batch size for the TE practical /tutorial shall be of 15 students. On forming the batches, if the strength of remaining student exceeds 7, then a new batch shall be formed.
- Vocational Training (evaluated at B.E. Part-I) of minimum 15 days shall be completed in any vacation after S.E. Part-II but before B.E. Part-I & the report shall be submitted and evaluated in B.E. Part-I
- Appropriate Elective I & II Subjects may be added when required.
- Student shall select one Self Learning Module at T.E. Part I and T.E. Part II each from Technical and Humanities and Social Sciences Group with at least one Self Learning Module from the Humanities and Social Sciences Group
- Curriculum for Humanities and Social Sciences Self Learning Modules is common for all under graduate programmes of faculty of Engineering and Technology
- Minimum four assignments for Self-Learning Modules at T.E. Part I and T.E. Part II shall be submitted by the students which shall be evaluated by a Module Coordinator assigned by institute / department
- Project group for T.E.(Electical) Part II Mini Project shall not be of more than **three** student
- Project group for B.E. (Electrical) Part I and Part II shall not be of more than **three** student.
- ICA shall be a continuous process based on student's performance in – class tests, assignments, homework, subject seminars, quizzes, laboratory books and their interaction and attendance for theory and lab sessions as applicable.
- For assessment of ISE, tests and mid-term written test shall be conducted and evaluated at institute level for 20 Marks and remaining 10 marks shall be based on performance in – assignments, viva-voce, quizzes, subject seminars with report writing, field visit, subject mini projects, application software training, case study with report writing.

DETAILED SYLLABUS

FOR

T.E. ELECTRICAL

ENGINEERING

PART – I

SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-I
POWER SYSTEM ANALYSIS

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week,4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25Marks
	ISE- 30Marks
	OE: 25Marks

Course Objectives

- To understand the representation of complex 3-phase power system in to a single line diagram and representation of equivalent circuit models for various power system equipment.
- To gain complete knowledge about load flow analysis by various methods for various power system networks.
- To understand the complete behavior of this power system network & power system equipment by stability analysis under various conditions.
- To understand the different faults of the power system by fault analysis.

Course Outcomes

- Students will be able to understand the complete knowledge for representing the power system network.
- Students will be able to know the complete load flow analysis in order to get the various losses.
- Students will be able to implement the knowledge to design for improve the power system operation.
- Students will be able to understand the various faults & analysis of faults.

SECTION-I

Unit 1– Representation of Power System Components **No of Lectures – 06**

- **Prerequisite:** Vectors, AC Circuit Fundamentals, Working principles of AC and DC Machines.

- **Objectives:**
  1. Revision of concepts of AC Circuits.
  2. Revision of concepts of Equivalent Circuits of AC machines.
  3. To introduce to student Single line diagram of Power systems.
  4. To make student understand Per unit system and its representation.

- **Outcomes:**

  After completing this unit, student -
  1. Can apply AC Circuit fundamentals to power system.
  2. Can calculate per unit values of various electrical quantities related to various elements used in power system.
  3. Can convert per unit values on any base.

- **Unit Content:**

  Power in single phase & Three phase circuit, Complex Power, Complex Power Balance, Equivalent circuits of Synchronous machines, Transmission line, Transformers and Loads,

Single line diagram of power system, reactance / impedance diagram, per unit system, per unit impedance diagram of power system, Per unit representation of transformer.

- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Numerical problems and derivations related to per unit system and its representations

Unit 2– Network Matrices **No of Lectures – 06**

- **Prerequisite:** concepts of admittance and impedance, graph theory, matrices
- **Objectives:**
  1. To make student understand behavior of impedance and admittance in the power system.
  2. To make student analyze impact of admittance in an interconnected network.
  3. To make student derive step by step algorithm of bus impedance matrix.
- **Outcomes:**
  After completing this unit, student –

  1. Can evaluate bus admittance and impedance matrices of different power structures.
  2. Is able to calculate various electrical quantities at buses and branches in power system
  3. Can derive step by step algorithm of bus impedance matrix
  4. Can evaluate Modified Bus Impedance matrix.
- **Unit Content:**
  Introduction, Formation of Y BUS by method of inspection and method of singular transformation, Formation of Bus Impedance matrix by step by step building algorithm, Formation of Modified Bus Impedance matrix

- **Content Delivery Methods:**
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Numerical problems and derivation related to bus admittance matrix, Numerical problems and derivation related to bus impedance matrix

Unit 3– Load Flow Studies **No of lectures – 09**

- **Prerequisite:**
  Concepts of AC Circuit, Numerical methods, concept of algorithm and flow chart

- **Objectives:**
  1. To make student derive power flow equation
  2. To make student apply concepts of numerical methods to power system.
  3. To make student evaluate different electrical quantities like voltage and powers at various bus bars in power system.
  4. To make student evaluate power flow through transmission lines in an interconnected power system.

- **Outcomes:**
  After completing this unit, student –

  1. Can identify the type of busbar with its significance.
  2. Is able to solve numerical problems to find power flow through a transmission line when connected between two sources.
  3. Is able to apply concepts of numerical methods required for complete load flow study of an interconnected circuit.
  4. Can compare between various load flow methods.

- **Unit Content:**
  Introduction, Power flow equations, Classification of buses, Operating constraints, Data for load flow, Gauss-Seidal Method – Algorithm and flow chart for PQ and PV bus Acceleration of convergence; Newton Raphson's Method –Algorithm and flow chart for NR Method in polar coordinates, Algorithm and flow chart for Fast Decoupled load flow method, Comparison of Load Flow Methods

- **Content Delivery Methods:**
  Chalk and talk, power point presentation, videos

- **Assessment Methods:**
  Numerical problems and derivation related to above Content.

Unit 4- Symmetrical Faults Analysis **No of lectures – 05**

- **Prerequisite:** Equivalent circuit of power system, single line diagram, Per unit impedance diagram.
- **Objectives:**
  1. To introduce to student concept of faults and its impacts on power system.
  2. To make student analyze rating of circuit breaker at different locations in power system.
  3. To introduce to student behavior of transmission line and synchronous machine under short circuits.

- **Outcomes:**
  After completing this unit, student –

  1. Can analyze rating of circuit breaker required for protection against fault.
  2. Can able to evaluate behavior of transmission line and synchronous machine under short circuits.

- **Unit Content:**
  Introduction of symmetrical faults, Percentage reactance, Short circuit KVA, Reactor control of short circuit currents, selection of circuit breaker rating, transients on a transmission line, Short-Circuit currents and the reactance of synchronous machines with and without load.
- **Content Delivery Methods:**
  Chalk and talk, power point presentation

- **Assessment Methods:**
  Numerical problems and derivation related to above Content.

SECTION-II

Unit 5- Symmetrical Components **No of lectures – 10**

- **Prerequisite:** Equivalent circuit of power system, single line diagram, per unit impedance diagram.

- **Objectives:**
  1. To make student understand concept of symmetrical components with its significance.
  2. To make student understand concept of sequence impedance and sequence network.
  3. To make student analyze sequence impedance and sequence networks
- **Outcomes:**
  After completing this unit, student –

  1. Can evaluate symmetrical components of electrical quantities.
  2. Can derive equations for Power in terms of symmetrical components.
  3. Can evaluate Sequence impedances and networks of power system elements like alternator, transformer and transmission line.

- **Unit Content:**
  Introduction, Resolution of unbalanced phasors into their symmetrical components, Power in terms of symmetrical components, Analysis of balanced and unbalanced loads against unbalanced 3 phase supply, Sequence impedances and networks of power system elements like alternator, transformer and transmission line.

- **Content Delivery Methods:**
  Chalk and talk, power point presentations, animation on wave propagation

- **Assessment Methods:**
  Numerical problems and derivation related to symmetrical components, Numerical related to Sequence impedances and networks.

Unit 6- Unsymmetrical Faults **No of lectures – 10**

- **Prerequisite:** per unit impedance diagram, symmetrical components, Sequence impedances and networks.

- **Objectives:**
  1. To make student understand different faults on power system.
  2. To make student understand behavior of power system under unsymmetrical faults
  3. To make student analyze short circuit calculations of different electrical quantities in power system
  4. To make student analyze rating of circuit breaker at different locations in power system.

- **Outcomes:**
  After completing this unit, student –

  1. Can derive fault current equations under various unsymmetrical faults.
  2. Can calculate unsymmetrical fault currents and voltages.
  3. Can analyze rating of circuit breaker required for protection against fault.
- **Unit Content:**
  L-G, L-L, L-L-G faults on an unbalanced alternator with and without fault impedance, Unsymmetrical faults on a power system with and without fault impedance, Open conductor faults in power system
- **Content Delivery Methods:**
  Chalk and talk, power point presentation
- **Assessment Methods:**
  Numerical and derivation related to above Content.

Unit 7- Stability Studies **No of lectures – 06**

- **Prerequisite:** concepts of stability, Mechanical dynamics.

- **Objectives:**
  1. To introduce to student stability issues in power system.
  2. To make student understand impact of stability on power system performance with its significance.
  3. To analyze stability parameters under various conditions.
- **Outcomes:**
  After completing this unit, student –

  1. Can define different types of power system stability.
  2. Can derive swing equation, critical clearing angle and time
  3. Can calculate different stability parameters.

- **Unit Content:**
  Introduction, rotor dynamics and the swing equation, Steady state and transient stability, Equal area criterion for transient stability evaluation and its applications, critical clearing angle and time
- **Content Delivery Methods:**
  Chalk and talk, power point presentations, animation on different types of antennas

- **Assessment Methods:**
  Derivation related to swing equation, Steady state and transient stability, Equal area criterion for transient stability, critical clearing angle and time and Numerical related to swing equation.

Text Books:

1. Elements of Power System Analysis, W.D.Stevenson, TMH,4th Edition
2. Modern Power System Analysis,.I. J. Nagrath and D.P.Kothari- TMH, 3rd Edition,2003.
3. Symmetrical Components and Short Circuit Studies, Dr.P.N.Reddy, Khanna Publishers
4. Computer Methods in Power System Analysis, Stag, G. W., and EI-Abiad, A. H.- McGraw Hill International Student Edition. 1968

Reference Books:

1. Power System Analysis, Hadi Sadat, TMH,2nd Edition.
2. Power system Analysis, R.Bergen, and Vijay Vittal, Pearson publications, 2nd edition, 2006.
3. Computer Aided Power system analysis, G.L., Kusic, PHI.Indian Edition, 2010 .
4. Power System Analysis,W.D.Stevenson & Grainger,TMH, First Edition, 2003.
5. Advanced Power System Analysis and Dynamics, Singh, L. P,New Age International (P) Ltd, New Delhi, 2001.
6. Computer Aided Power System Operations and Analysis"- Dhar, R. N, TMH, 1984.

Internal Continuous Assessment (ICA):

ICA shall consist of at least 8 simulations/ programs covering above syllabus but not restricted to the following:

1. Y Bus formation for power systems with mutual coupling by singular transformation
2. Y Bus formation for power systems without mutual coupling by singular transformation
3. Y Bus formation for power systems with mutual coupling by inspection Method.
4. Y Bus formation for power systems without mutual coupling by inspection Method.
5. Determination of bus currents, bus power and line flow for a specified system voltage (Bus) Profile
6. Formation of Z-bus (without mutual coupling) using Z-bus building Algorithm.
7. To obtain swing curve and to determine critical clearing time and regulation for a single machine connected to infinite bus through a pair of identical transmission lines under 3- phase fault on one of the lines for variation of inertia constant/line parameters /fault location/clearing time/pre-fault electrical output.
8. Write a program to perform load flow using Gauss- Seidel method
9. Write a program to perform load flow using NR method
10. Write a program to perform load flow using decoupled method
11. To determine fault currents and voltages in a single transmission line system with star delta transformers at a specified location for LG fault.
12. To determine fault currents and voltages in a single transmission line system with star delta transformers at a specified location for LL fault.
13. To determine fault currents and voltages in a single transmission line system with star delta transformers at a specified location for LLG fault.

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SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-I
Control Systems-I

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week, 4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25Marks
	ISE- 30Marks
	OE: 25Marks

This course covers the fundamentals of Control Systems viz, types and block diagram representations, Signal flow graph. It includes the modelling of electrical and mechanical systems and their transfer functions. It also introduces analysis of linear time-invariant systems in time domain and frequency domain. It includes concepts of stability in time domain and frequency domain.

Course Prerequisite:

Student should have mathematical background of differential equations, able to apply kirchoff's laws. Also students should have the knowledge of Laplace transform.

Course Objectives

1) To make student understand the facing challenges posed by growing trends in control systems
2) To make students to represent the system by block diagram and signal flow graph.
3) To enhance the describing ability of the students to represent the control system mathematically.
4) To enhance the describing ability of the students to analyze the system in time and frequency domain.
5) To enable student to use transforms techniques for the analysis of LTI systems.

Course Outcomes

At the end of course

1) Students can analyze and represent the control system mathematically.
2) Students can represent the system by block diagram and signal flow graph and find transfer function
3) Students can analyze the control system in Time and frequency Domain.
4) Students are able to find stability of LTI system
5) Students can determine system stability using Root Locus and Bode plot.

SECTION I

Unit 1: Introduction to Control System **No of Lectures -8**

- **Prerequisite:** Laplace transform, Network Systems.
- **Objectives:**
  1. To introduce student different types of control systems.
  2. To make student to find the transfer function of the electrical systems as well as positive and negative feedback.

• **Outcomes:**

After completing this unit, student –

1. Can identify the type / classification of control system.
2. Can find out the transfer function.
3. Can identify the basic components of control system

• **Unit Content**

Definition, basic components & classification of general control system, Open loop & Close Loop control systems, advantages & disadvantages, examples, Positive & negative feedback, Transfer Function of open loop and closed loop control system.

• **Content Delivery Methods:**

Chalk and talk

• **Assessment Methods:**

Numerical and derivations related to Transfer functions

Unit 2: Mathematical Models of Physical Systems **No of Lectures -8**

- **Prerequisite:** Differential equations, Laplace transforms
- **Objectives:**

1. To introduce student to represent the system by differential equation
2. To make the students familiar with analogous systems.
3. To make students to find the Transfer functions of AC/DC Servo motors.

•**Outcomes:**

After completing this unit, student –

1. Can be able to obtain the transfer function of the system
2. Can understand the analogy between electrical and mechanical systems
3. Able to find the Transfer functions of AC/DC Servo motors

• **Unit Content**

Introduction, Differential equations of physical systems & solutions for these differential equations, Transfer Function of electrical and mechanical (Translational and Rotational) systems, electrical analogy of mechanical systems (F-V & F-I), Transfer Function of AC & DC Servomotor.

• **Content Delivery Methods:**

Chalk and talk, power point presentation

- **Assessment Methods:**

Numerical related to Transfer functions of electrical and mechanical systems.

Unit 3: Reduction of Multiple Systems **No of Lectures -10**

- **Prerequisite:** Differential equations formation, Laplace transforms
- **Objectives:**
  1. To make the students to represent the system by block diagram and SFG.
  2. To make the students to find Transfer function of various systems by block diagram reduction techniques
  3. To make the students to convert the block diagram to SFG and vice versa.
  4. To find the sensitivity of the system.
  5. To study the effect of feedback on system parameters

- **Outcomes:**

After completing this unit, student can be able to –

1. Represent the system by block diagram and SFG.
2. Find Transfer function of various systems by block diagram reduction techniques.
3. Convert the block diagram to SFG and vice versa and find the transfer function.
4. Find the sensitivity of the system.

- **Unit Content**

Reduction of multiple systems & feedback characteristic, Block diagram representation, Signal flow Graph (SFG), Conversion of Block diagram to SFG. Mason's Gain formula and its application for SFG, Definition of sensitivity, and effect of feedback on system parameter variation, system dynamics & disturbance signal.

- **Content Delivery Methods:**

Chalk and talk, power point presentation

- **Assessment Methods:**

Numerical related to Transfer functions of systems by block diagram and Mason's Gain Formula

SECTION-II

Unit 4: Time-Response Analysis **No of Lectures -10**

- **Prerequisite:** Transfer function, poles and zeros, Transients
- **Objectives:**
  1. To make student understand Standard test signals and their representation.
  2. To make student understand response of first order and second order systems
  3. To make student understand Time response specifications
  4. To make student understand Steady state errors & error constants Kp, Kv and Ka,
  5. To make student understand P, PI, PD and PID Controller
- **Outcomes:**

After completing this unit, student can be able to –

1. Recognize Standard test signals.
2. find the response of first order and second order systems
3. Determine transient & Steady state errors
4. Apply concepts of P, PI, PD and PID Controller

• **Unit Content:**
Standard test signals, poles, zeros & system response, response of first order and second order systems to standard input, Time response specifications, Steady state errors & definitions of error constants Kp, Kv and Ka, P, PI, PD and PID Controller.

• **Content Delivery Methods:**
Chalk and talk, Power point presentation

- **Assessment Methods:**
Derivations & Numerical on above unit contents

Unit 5: Stability & Root Locus Techniques **No of Lectures -08**

- **Prerequisite:** Transfer function, S-plane representation of poles and zeros
- **Objectives:**
  1. To make the students Understand the concept of stability
  2. To make the students familiar with different analytical techniques for stability analysis
  3. To make the students able to understand the procedure for root locus
  4. To make the Students learn about stability using root locus
- **Outcomes:**

After completing this unit, student can be able to –

1. Analyze for stability related to pole location
2. Apply different analytical techniques for stability analysis.
3. sketch & apply root locus
4. apply the concept of root locus for stability analysis

• **Unit Content**
Concept of stability & necessary condition, Root-Harwitz criterion with special cases, location of roots in s-plane, concept of root locus diagram, properties and rules for construction of root locus, Determination of stability from root locus.

• **Content Delivery Methods:**
Chalk and talk, power point presentation

- **Assessment Methods:**

Theoretical and Numerical on above contents

Unit 6: Frequency Response Analysis **No of Lectures -08.**

- **Prerequisite:** Transfer function, S-plane representation of poles and zeros
- **Objectives:**
  1. To make the students familiar with Correlation between Time domain and Frequency domain
  2. To make the students Understand the concept of *Bode Plot*
  3. To make the students Understand the concept of *Polar Plot*
  4. To make the students able to sketch *Bode Plot/ Polar Plot* and use
  5. To make the Students *learn* about *stability* using *Bode Plot*

• **Outcomes:**

After completing this unit, student can be able to –

1. Correlate between Time domain and Frequency domain
2. Can Apply the concept of *Polar Plot*
3. sketch *Bode Plot/ Polar Plot*
4. analyze the control system for stability

• **Unit Content:**

Introduction to frequency response of system, Frequency domain specifications, Correlation between Time domain and Frequency domain, polar plot & bode plot for frequency function. Minimum phase function, gain margin & phase margin, determination of stability using Bode Plot.

• **Content Delivery Methods:**

Chalk and talk, power point presentation

Assessment Methods:

Theoretical and Numerical on above contents

Text Books:

1. I. J. Nagrath, M. Gopal "Control System Engineering", 5th Edition. New Age International Publishers.
2. Control System Engineering by R Anandanatrajan, P Ramesh Babu, 2nd Edition, Scitech
3. Benjamin C. Kuo, "Automatic Control Engineering", Prentice Hall of India Pvt. Ltd.
4. K. Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd.
5. Control system principles and design, M. Gopal, TMH publication, 3rd edition, 2008

Reference Books:

1. Feedback Control Systems, C. L. Phillips, R. D. Harbor PHI publication, 1988
2. Richard C.Dorf, Robert H. Bishop," Modern Control Systems", eleventh edition.
3. Control systems by Smarajit Ghosh, Pearson Education 2nd Edition

Internal Continuous Assessment (ICA):

ICA consists of minimum 8 experiments of following

1) To verify potentiometer as transducer and error detector.
2) To verify Synchro as transducer.
3) To verify Synchro as error detector.
4) AC position control system.
5) DC position control system.
6) Time response of first order system.
7) Step response of second order system using R, L and C.
8) To study the effect of P, PI & PID Controller on a 2nd order system.
9) Transient response specifications of second order system using MATLAB.
10) Root locus using MATLAB.
11) Bode plot using MATLAB.

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SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-I
Microprocessor and Microcontroller

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week, 4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25 Marks
	ISE- 30 Marks
	POE: 50 Marks

This course introduces Introduction to Microprocessor, Microcontroller & their Instruction Set. It gives the detail idea of interfacing of Microcontrollers with various external peripherals.

Course Prerequisite:

Students shall have the knowledge of Basic Number System, Binary Arithmetic & Logical Operations. He/ She should also have the knowledge of electrical machines & basic electronics.

Course Objectives:

1. To study the architecture and addressing modes of 8051 and to write assembly language programs of 8051.
2. To write assembly language program in microcontroller 8051 for various applications.

Course Outcomes:

1. To impart knowledge on the architecture and basic concepts of Microprocessor and Microcontroller.
2. To create the memory and I/O interfacing techniques with 8051.
3. To write assembly language program in microcontroller 8051 for various applications in Electrical Engineering.

SECTION I

Unit 1: Architecture of Intel 8085: **No. of lectures- 08**

- **Prerequisite:**
  Number Systems, basics of electronics.

- **Objectives:**
  1. To introduce pin diagram & architecture of 8085.
  2. To make students to understand the working & applications of 8085.

- **Outcomes:**
  After completing this unit, students -
  1. Can apply the basics of programming in 8085.
  2. Can find the application of 8085 in electrical engineering.

- **Unit Content:**

  Architecture of Intel 8085 microprocessor, functional PIN diagram, ALU, Instruction register-decoder, Timing and control, general purpose registers, Data & Address bus, De-multiplexing of Address-Data Bus, Generation of Control Signals, Instruction set.

- **Content Delivery Methods:**
  Chalk and talk, power point presentations.

- **Assessment Methods:**
  Theoretical questions and Assembly Language Programs related to above contents.

Unit 2: 8051 Microcontroller **No. of lectures- 10**

- **Prerequisite:**
  Basics of 8085, basics of digital electronics.

- **Objectives:**
  1. To introduce the difference between 8085 & 8051.
  2. To introduce pin diagram & architecture of 8051.

- **Outcomes:**
  After completing this unit, students -
  1. Can find difference between 8085 & 8051.
  2. Can apply the basics of 8051.

- **Unit Content:**

  Comparison of microprocessor & microcontroller, Overview of 8051 family, Architecture of 8051, De-multiplexing of Address-Data Bus, Functional pin description, Memory organization, Special Function Registers and various registers of 8051.

- **Content Delivery Methods:**
  Chalk and talk, power point presentations.

- **Assessment Methods:**
  Theoretical questions related to above contents.

. **Unit 3: Assembly language programming** **No. of lectures- 08**

- **Prerequisite:**
  Basics of 8051.

- **Objectives:**
  1. To introduce the Addressing Modes of 8051.
  2. To introduce the Instruction set of 8051.
  3. To introduce the Assembly Language Programming of 8051.

- **Outcomes:**
  After completing this unit, students -
  1. Can use the instructions in 8051.
  2. Can build an Assembly Language Program for various applications by using 8051.

- **Unit Content:**

  Addressing modes, Instruction set and Assembly language programming.

- **Content Delivery Methods:**
  Chalk and talk, power point presentations.

- **Assessment Methods:**
  Theoretical questions & Assembly Language Programs related to above contents.

SECTION-II

Unit 4: Hardware overview: **No. of lectures- 08**

- **Prerequisite:**
  8051 Architecture & Pin diagram, Basics of Electronics.

- **Objectives:**
  1. To introduce Hardware Structure Overview of 8051.
  2. To introduce Assembly Language Programming related to interfacing techniques of 8051 with external devices.

- **Outcomes:**
  After completing this unit, students -
  1. Can sketch the Hardware Structure of 8051.
  2. Can find the interfacing techniques of external devices with 8051.

- **Unit Content:**
  Study of port structure, interrupt structure, timers, counters and their programming.

- **Content Delivery Methods:**
  Chalk and talk, power point presentations.

- **Assessment Methods:**
  Theoretical questions & Assembly Language Programs related to above Contents.

Unit 5: 8051 Interfacing: **No. of lectures-14**

- **Prerequisite:**
  8051 Hardware Structure, Basics of Electronics.

- **Objectives:**
  1. To introduce basics of interfacing techniques of 8051.
  2. To introduce Assembly language programming of 8051 with interfacing.

- **Outcomes:**
  After completing this unit, students -
  1. Can apply the interfacing of 8051 with External Memories.
  2. Can find the different applications controlled by 8051.

- **Unit Content:**

  Semiconductor memory, memory address decoding, interfacing with External ROM, 8051 data memory space, accessing External data memory in 8051. Interfacing of LCD, Matrix keyboard, ADC 0809, DAC 0808, RTC DS12887.

- **Content Delivery Methods:**
  Chalk and talk, power point presentations.

- **Assessment Methods:**
  Theoretical questions & Assembly Language Programs related to above Contents.

Unit 6: Electrical Applications of 8051: **No. of lectures-04**

- **Prerequisite:**
  8051 Hardware Structure, Basics of Electronics, Interfacing Techniques of 8051.

- **Objectives:**
  1. To introduce interfacing techniques of 8051 with different electrical components & devices.
  2. To introduce use of 8051 in electrical engineering.

- **Outcomes:**
  After completing this unit, students -
  1. Can interface 8051 with different electrical components & devices.
  2. Can find the different applications in electrical engineering controlled by 8051.

- **Unit Content:**
  Power factor control Relay, Temperature indicator & controller, stepper motor and DC motor control.

- **Content Delivery Methods:**
  Chalk and talk, power point presentations.

- **Assessment Methods:**
  Theoretical questions & Assembly Language Programs related to above Contents.

Text Books:

1. Muhammad Ali Mazidi, "The 8051 Microcontroller and embedded systems", Pearson Education.
2. Ramesh S. Gaonkar ,"Microprocessor – Architecture, Programming and Applications with the 8085", Penram International Publisher , Fifth Edition,2006.
3. Ray.A.K. & Bhurchandi.K.M, "Advanced Microprocessor and Peripherals – Architecture, Programming and Interfacing", Tata Mc Graw Hill, 2006.

Reference Books:

1. Kenneth Ayala, "The 8051 Microcontroller Architecture, Programming and Applications", 2nd Edition, Penram International.
2. Douglas V.Hall, "Microprocessors and Interfacing: Programming and Hardware", second edition, Tata Mc Graw Hill, 2006.
3. Peter Abel, "IBM PC Assembly language and programming", fifth edition, Pearson education / Prentice Hall of India Pvt. Ltd, 2007.
4. Device datasheet- ATMEL, DALLAS.
5. 8051 Manual (Intel).

Internal Continuous Assessment (ICA) :

Minimum Eight experiments should be performed in the laboratory:

List of experiment is as follows:

1. Two 8 Bit and 16 Bit numbers Addition using 8085.
2. Two 8 Bit and 16 Bit numbers Subtraction using 8085.
3. Two 8 Bit and 16 Bit numbers Addition Using Arithmetic Operation of 8051 Microcontroller.
4. 8 Bit Subtraction Using Arithmetic Operation of 8051 Microcontroller.
5. 8 Bit Multiplication Using Arithmetic Operation of 8051 Microcontroller.
6. 8 Bit Division Using Arithmetic Operation of 8051 Microcontroller.
7. Logical Operations Using 8051 Microcontroller.
8. Program for the Block Transfer Using 8051 Microcontroller.

9. Program for the Block Exchange Using 8051 Microcontroller.
10. Interfacing LCD to 8051 Microcontroller.
11. Interfacing Matrix/Keyboard to 8051 Microcontroller.

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SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-I
Engineering Economics & Management

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week, 4 Credits	**ESE –** 70 Marks
Tutorial: - 1 Hr./Week , 1 Credit	**ICA-**25 Marks
	ISE- 30 Marks

This course introduces engineering economics and industrial management which works on basic economics terms and industrial management

Course prerequisite:

Students shall have basic knowledge of economics related to engineering. He/She shall also have basic knowledge of industrial and business organization.

Course Objectives:

- The students should know the engineering economics aspects & Industrial management related to the course of the electrical engineering which will be useful while doing the job in the industries or doing own business.

Course Outcome:

After successful completion of this course-

1. Students will be able to use economic aspects related to industry.
2. Students will be able to analyze managerial skills required in industries.
3. Students will be more competent while doing the job in the industries.

SECTION I

Unit 1: Basic Economics **No. of lectures-10**

- **Prerequisites:**

  Economic terms

- **Objectives:**

1. To make the student understand the scenario of economics
2. To make students to understand Indian and global economy

- **Outcome:**

  After completion of this unit students can use economic terms related to technical issues

- **Unit contents:**

  Micro & macroeconomics ,trade cycle, payback period, value engineering, ABC analysis , Make or buy decision ,Economic Order Quantity (EOQ), cost control, cost ratio, cost reduction

- **Content delivery methods:**

  Chalk and talk

- **Assessment Methods:**

  Numerical related to EOQ and payback period

Unit 2: Business Organization **No. of lectures-10**

- **Prerequisites:**
  Basics of business organization
- **Objectives:**
  1. To make students understand formation of business firms
  2. To make students understand hierarchy in the organization.
- **Outcomes:**
  After completing this unit, students-
  1. Can analyze how to step in the business and entrepreneur
  2. Can compare various structures of business organization
- **Unit contents:**
  Forms/Types of business organization – proprietorship, Partnership, Private and Public Limited, Joint stock Company, Organization structure & Characteristics of different organizations
- **Content delivery methods:**
  Chalk and talk, power point presentation
- **Assessment Methods:**
  Theoretical Questions related to above contents

Unit 3: Indian Economy **No. of lectures-06**

- **Prerequisites:**
  economic terms and definition
- **Objectives:**
  1. To make students understand Indian and Global economy
  2. To make students understand problems in Indian and Global economy.
- **Outcomes:**
  After completing this unit, students-
  1. can define Inflation and Deflations
  2. Can analyze Gross Domestic Product
- **Unit contents:**
  Infrastructure of Indian Economy, Power sector & agricultural sector, science & technological developments, present & future electrical energy requirements in India.
- **Content delivery methods:**

Chalk and talk, videos

- **Assessment Methods:**
  Theoretical Questions related to above contents

Section II

Unit 4: Industrial Management **No. of lectures-12**

- **Prerequisites:**
  Concept of Management
- **Objectives:**
  1. To make students to understand Industrial Management Aspects
  2. To make students to understand Industrial Structure
- **Outcomes:**
  After completing this unit, students-
  1. Can solve different types of Industrial Problems related to Management
- **Unit contents:**

  Functions of management, planning, organizing, staffing, directing, controlling. Project planning-Implementation, monitoring and control, PERT & CPM methods for project implementation, methods of reducing project costs, management Information systems (MIS)

- **Content delivery methods:**
  Chalk and talk, Power Point Presentation
- **Assessment Methods:**
  Numerical related to PERT and CPM technique

Unit 5: Small scale industries & entrepreneurship **No. of lectures-10**

- **Prerequisites:**
  Concept of Management
- **Objectives:**
  1. To make students understand Role of Manager
  2. To make students understand Duties of manager.
- **Outcomes:**
  After completing this unit, students are able to-
  1. Find the various schemes and facilities for entrepreneurship development given by the government
- **Unit contents:**
  Definitions & roll of small sectors, Advantages of SSI, Industrial policy, Self-employment for engineers, steps for setting and starting SSI, Entrepreneurship – growth, functions and facilities for entrepreneurship development given by the government.
- **Content delivery methods:**
  Chalk and talk, Power Point Presentation
- **Assessment Methods:**
  Theoretical questions on above content

Unit6: Industrial safety & related industrial acts **No. of lectures-04**

- **Prerequisites:**
  Need of industrial safety and essential acts
- **Objectives:**
  1. To make students understand safety importance
  2. To make students understand about labor law.
- **Outcomes:**
  After completing this unit students-
  1. Are able to apply the factory acts and Indian Electricity Acts
- **Unit contents:**
  Rules & advantages of industrial safety, Indian factory act, and Indian electricity act 2003 and 2011.
- **Content delivery methods:**
  Chalk and talk, power point presentations
- **Assessment Methods:**
  Theoretical questions on above content

Text Books:

1. Industrial organization and engineering economics by T.R.Banga, S.C.Sharma (Khanna Publishers)
2. Indian Economy By,Ruddar Datt and KPM Sundharum (S.C.Chand publishers)
3. Industrial Engineering and management by, O.P.Khanna (Dhanapatrai Publications) 2008 edition

Internal Continuous Assessment (ICA):

ICA shall consist of at least 6 assignments and 2 Case studies covering above syllabus.

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SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-I
Electromagnetic Engineering

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week, 4 Credits	**ESE** – 70 Marks
Tutorial: - 1 Hr/Week , 1 Credit	**ICA**-25 Marks
	ISE- 30 Marks

This course introduces electromagnetic field theory which deals with electric and magnetic field vectors.

Course Prerequisite:

Student shall have knowledge of circuit theory and shall also have basic knowledge of vectors and Del operator.

Course Objectives:

1. To make student understand basics of coordinate systems, significance of divergence, gradient and curl.
2. To introduce to student basic laws of electrostatic and magneto static.
3. To make student derive Maxwell's equations under different conditions.

Course Outcomes:

1. Student can solve numerical problems on coordinate systems, divergence, curl and gradient.
2. Student can derive basic laws of electrostatic and magneto static and can apply them for different fields.
3. Student can derive Maxwell's equations under different conditions

Section I

Unit 1–Vector Analysis & Coulomb's law **No of lectures – 10**

- **Prerequisite:** Scalar and vector quantities**,** trigonometry, differentiation, integration, basics of electricity.

- **Objectives:**
  1. Revision of concepts of scalars and vectors.
  2. To introduce to student different coordinate systems.
  3. To make student understand vector transformation techniques.
  4. To make student understand applications of Del operator.
  5. To make student understand concepts of static electric field and charge distribution.
  6. To make student analyze electric field intensity and density due to various charge distributions.

- **Outcomes:**
  After completing this unit, student -
  1. Can apply Del operator to solve numerical.
  2. Can calculate length, surface and volume in different coordinate systems.
  3. Can convert vectors in different coordinate system.
  4. Can evaluate force using Coulomb's law
  5. Is able to calculate electric filed intensity and density over different charge distributions.

- **Unit Content:**
  Scalars & vectors, vector algebra, vector components & vectors, vector field, Dot & cross products, Introduction to Co-ordinate System – Rectangular – Cylindrical and Spherical Co-ordinate System, Introduction to line, Surface and Volume Integrals, Definition of Curl, Divergence and Gradient, Coulomb's Law in Vector Form, Definition of Electric Field Intensity, Electric field due to continuous charge distribution, Electric Field due to line charge & sheet charge
- **Content Delivery Methods:**
  Chalk and talk, power point presentations, animation on coordinate system, 3D models

- **Assessment Methods:**
  Numerical problems and derivation related to above Content.

Unit 2–Static Electric Fields **No of lectures – 10**

- **Prerequisite:** Vector calculus, basics of electricity, Coulomb's Law.
- **Objectives:**
  1. To make student derive Gauss's law and understand its applications.
  2. To make student apply Del operator to calculate divergence.
  3. To make student derive & apply Divergence Theorem.
  4. To make student evaluate potential due to various charges in electric field.

- **Outcomes:**
  After completing this unit, student –

  1. Can derive point form of Gauss's law
  2. Can derive & apply Divergence Theorem.
  3. Can evaluate energy and potential associated with charge distribution.
- **Unit Content:**
  Gauss Law – Applications, point form; Divergence theorem, Electric Scalar Potential, Relationship between potential and electric field, Electric Flux Density , Energy & potential energy expended in moving a point charge in an electric field, Line integral, potential difference & potential, potential gradient, potential field of a point charge & system of a charges, dipole, energy density in electrostatic field
  Content Delivery Methods:
  Chalk and talk, power point presentations

- **Assessment Methods:**
  Numerical problems and derivation related to above Content.

Unit 3–Conductors & Dielectrics **No of lectures – 06**

- **Prerequisite:** Concept of Electric fields, Nature of materials.
- **Objectives:**
  1. To make student derive point form of ohm's law.
  2. To make derive continuity equation for current
  3. To introduce to Capacitance.
  4. To make student evaluate Capacitance of parallel plate and spherical capacitors
  5. To make student compare electric field and magnetic field parameters.
- **Outcomes:**
  After completing this unit, student –

  1. Is able to derive point form of ohm's law.
  2. Is able to derive apply Poisson's and Laplace's equation.
  3. Is able to solve numerical problems to Capacitance of parallel plate and spherical capacitors
  4. Can derive and evaluate boundary conditions for electric fields.
- **Unit Content:**
  Electric current, Current density, point form of ohm's law, continuity equation for current, Poisson's and Laplace's equation, Uniqueness, Electric Polarization, Nature of dielectric materials- Definition of Capacitance, calculation of Capacitance of parallel plate and spherical capacitors, Electrostatic energy and energy density, Boundary conditions for electric fields

- **Content Delivery Methods:**
  Chalk and talk, power point presentation, videos

- **Assessment Methods:**
  Numerical problems and derivation related to above Content.

Section II

Unit 4–Static magnetic field **No of lectures – 12**

- **Prerequisite:**
  Concepts of magnetic field, magnetic flux lines, applications of magnetic field

- **Objectives:**
  1. To make student derive Biot Savart law, Ampere's law
  2. To make student apply Curl, Stroke's Theorem for getting magnetic flux and magnetic flux density, scalar and vector magnetic potentials.
  3. To make student evaluate force on current element and between current elements using Lorentz force equation.

- **Outcomes:**
  After completing this unit, student –

  1. Can apply Biot Savart law to finite, infinite and circular current element.
  2. Is able to solve numerical problems to find magnetic field intensity and magnetic flux density with various types of current distributions.
  3. Can apply Ampere's circuit law for symmetrical surface and asymmetrical surface.

- **Unit Content:**
  The Biot-Savart Law in vector form, Magnetic Field intensity due to a finite and infinite wire carrying a current, Magnetic field intensity on the axis of a circular and rectangular loop carrying a current, Ampere's circuital law and applications, Magnetic flux density, Curl Stokes theorem, Lorentz force equation for a moving charge, Scalar and Vector Magnetic Potential
- **Content Delivery Methods:**
  Chalk and talk, power point presentation, videos

- **Assessment Methods:**
  Numerical problems and derivation related to above Content.

Unit 5-Fields in Magnetic materials **No of lectures – 08**

- **Prerequisite:** Field theory and circuit theory.
- **Objectives:**
  1. To introduce to student concept of energy stored in magnetic field and inductors.
  2. To derive magnetic vector potential and boundary conditions
  3. To make student compare electric field and magnetic field parameters.
- **Outcomes:**
  After completing this unit, student –

  1. Is able to derive magnetic vector potential and boundary conditions.
  2. Can compare between electric and magnetic field.

- **Unit Content:**
  Definition of Inductance, Inductance of loops and solenoids, mutual inductance, Energy density in magnetic fields, Nature of magnetic materials, magnetization and permeability, magnetic boundary conditions, Energy in a inductor & energy density

- **Content Delivery Methods:**
  Chalk and talk, power point presentations
- **Assessment Methods:**
  Numerical problems and derivation related to above Content.

Unit 6 -Maxwell's equations **No of lectures –06**

- **Prerequisite:**
  Faraday's law, Gauss's law, Ampere's law in point form and integral form.
- **Objectives:**
  1. To introduce to student concept of displacement current and conduction current density
  2. To make student derive mathematical proof of Maxwell's equation.
  3. To introduce to student concept of Maxwell's equations for different fields
- **Outcomes:**
  After completing this unit, student –

  1. Can analyze difference between displacement current and conduction current density
  2. Can derive Maxwell's equation in differential and integral forms.
  3. Can evaluate Maxwell's equations under static, dynamic and harmonically time varying field conditions.
- **Unit Content:**
  Continuity equation for static conditions, displacement current and current density, Maxwell's equations in integral form and point form, Maxwell's equations for static, time varying field and harmonically varying field.
- **Content Delivery Methods:**
  Chalk and talk, power point presentation
- **Assessment Methods:**
  Derivations related to above Content.

Text Books:

1. Electromagnetic Engineering, William Hyte, 7th Edition, Tata Mc Graw Hill
2. Electromagnetic field theory & Transmission Lines, GSN Raju, Pearson Education
3. Schaum's series in electromagnetic, Edminister McGraw Hill publications, 3rd edition.

Reference Books:

1. Problems and solutions in electromagnetic, William Hyte, Tata Mc Graw Hill
2. Elements of Engineering Electromagnetics, M.N.O.Sadiku Oxford University Press, Third edition.
3. Electromagnetic Corson and lerrain CBS publications, 2nd edition.

Internal Continuous Assessment (ICA)

ICA shall consists of minimum six tutorials based upon above curriculum. Tutorial shall include numerical problems and derivations.

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SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-I
Electrical Workshop

Teaching Scheme	Examination Scheme
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25 Marks

Course Objectives:

1. To develop practical workshop skills in the students.
2. To provide students a widespread knowledge and understanding of the workshop tools and other facilities.

Course Outcomes:

At the end of the course student is able to grasp the applications of workshop equipment, wiring accessories and printed circuit boards and their importance in the practical field

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Electrical workshop

To perform and record any six of following experiments

1. Understanding of different types of switches such as SPST, SPDT, DPST, DPDT, TPST, TPDT
2. Understanding of different types of switchgears such as MCCB, MCB, ELCB, Isolators, HRC fuses
3. Understanding Different types of meters such as analog multimeter, clamp meter, trivector meter , power quality analyser , RLC meters etc.
4. Measurement of insulation resistance and earth resistance.
5. Understanding Different types of power supply, function generator, DSO, CRO.
6. Study and performing of motor winding.
7. Installation of plate, pipe and grid earthing.
8. Types of wiring, Industrial, domestic wiring and panel wiring etc.
9. PCB design and fabrication
10. Soldering and desoldering of components on PCB.
11. Troubleshooting in electronic circuits.

Carry out at least one activity of the following to give the students an insight to their practical approach in diverse electrical field.

1. Site visit to nearby apartments/industries to understand the electrical wiring.
2. Workshop on PCB design using any suitable and available software like ORCAD, eagle, Proteus etc.
3. Workshop on Solar panel installation.
4. Workshop on motor rewinding.

DETAILED SYLLABUS

FOR

T.E. ELECTRICAL

ENGINEERING

PART – II

SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-II
Electrical Utilization

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week, 4 Credits	**ESE** – 70 Marks
Tutorial: - 1 Hr/Week , 1 Credit	**ICA**-25 Marks
	ISE- 30 Marks

Course Prerequisite:
Basics of Electrical Engineering, Effects of electric current, Control circuit design basics, awareness about artificial lighting, Characteristics and application of different electric motors, awareness about traction, awareness about energy conservation

Course Objectives

1. To provide the students the fundamental concepts of train movement tractive effort used in traction
2. To analyze the accessing techniques for braking system implementation in traction
3. To comprehend the different issues related to heating, welding and illumination
4. To make the students aware about the importance of maximizing the energy efficiency by optimum utilization of electrical energy
5. To develop self and lifelong learning skills, introduce professionalism for successful career

Course Outcomes

1. Students will able to design a suitable scheme of speed control for the traction systems
2. Students will able to identify a heating/ welding scheme for a given application
3. Students will able to maintain/ Trouble shoot various lamps and fittings in use
4. Students will be able to understand the importance of maximizing the energy efficiency by its optimum utilization and mould their practical work in professional world accordingly

SECTION-I

Unit-1 Traction Systems **No of Lectures- 10**

- **Prerequisite:**
  Awareness about traction
- **Objectives:**
  1. To introduce to student basic terms used in traction system
  2. To introduce student to types of speed time curve
- **Outcomes:**
  After completing this unit-
  1. Can define different terms in traction system
  2. Can analyze selection of speed time curves for different services
- **Unit Content:**
  Introduction, different system of traction, systems of electric traction, speed time curve for different services, calculation by trapezoidal and quadrilateral speed time curve, mechanics of train movement, tractive effort for propulsion of train, determination and factors

effecting specific energy consumption using speed time curve, dead weight, accelerating weight and adhesive weight, introduction to metro system, mono rail system.

- **Content Delivery Methods:**
  Chalk and talk, Power point presentation, Video lectures
- **Assessment Methods:**
  Derivation, Numerical, Theoretical questions on above unit content.

Unit-2 Control of Traction Motors and Train Lighting **No of Lectures- 10**

- **Objectives:**
  1. To introduce to student different braking systems
  2. To introduce student to speed control
- **Outcomes:**
  After completing this unit-
  1. Can define different types of braking systems and lighting system
  2. Can analyze selection of control and auxiliary equipment
- **Unit Contents:**
  Desirable characteristic of traction motors, suitability of d.c. series motor, 3 phase induction motor for traction, control of traction motors -series-parallel control, shunt and bridge transition, electrical breaking, regenerative breaking in traction, control equipment and auxiliary equipment, train lighting system.
- **Content Delivery Methods:**
  Chalk and talk, Power point presentation, Video lectures
- **Assessment Methods:**
  Derivation, Numerical, Theoretical questions on above unit content.

Unit-3 Selection of Motors for Industrial Applications **No of Lectures- 06**

- **Objectives:**
  To make student understand concepts, operation and application of different types of motors
- **Outcomes:**
  After completing this unit-
  Can analyze selection of motor for particular application
- **Unit Contents:**
  Motor selection e. g. in textile industries, machine tools, rolling mills, sugar mills, cranes and Lifts
- **Content Delivery Methods:**
  Chalk and talk, Power point presentation, Video lectures
- **Assessment Methods:**
  Theoretical questions

SECTION-II

Unit-4 Electric Heating and Welding **No of Lectures- 11**

- **Objectives:**
  To ensure that the knowledge acquired can be applied in various fields such as electric heating and welding
- **Outcomes:**

After completing this unit-

Students will get technical knowledge of modern heating and welding techniques in practical world

- **Unit Contents:**

  Advantages and classification of electric heating, resistance heating, electric arc furnaces, induction heating and dielectric heating, Electric welding, resistance and arc welding, comparison between a. c. and d. c. welding, modern welding techniques like ultrasonic welding, laser welding
- **Content Delivery Methods:**

  Chalk and talk, Power point presentation, Video lectures
- **Assessment Methods:**

  Theoretical questions, Numerical on resistance heating

Unit-5 Illumination **No of Lectures- 09**

- **Objectives:**

  To develop ability amongst the students to analyze the performance different sources of light, illumination schemes
- **Outcomes:**

  After completing this unit-

  1. Students will be able to design simple illumination schemes
  2. Can analyze selection of sources of light
- **Unit Contents:**

  Introduction, terms used in illumination, laws of illumination (numerical), factors to be considered for design of illumination scheme , source of light, discharge lamps, MV and SV lamps, comparison between tungsten filament lamps and fluorescent tubes, basic principles of light control, street lighting and flood lighting
- **Content Delivery Methods:**

  Chalk and talk, Power point presentation
- **Assessment Methods:**

  Numerical, Theoretical questions

Unit-6 Energy Conservation **No of Lectures- 06**

- **Objectives:**

  To make the students aware about the importance of maximizing the energy efficiency by optimum utilization of electrical energy.
- **Outcomes:**

  After completing this unit-

  Students will be able to define the importance of maximizing the energy efficiency by its optimum utilization
- **Unit Contents:**

  Introduction, Motivation for Energy Conservation, Principles of Energy Conservation, Energy Conservation Planning, Energy Conservation in Industries, Small Scale Industries, Electric Generation, Transmission and Distribution, Energy Conservation in Household and Commercial Sectors, Energy Conservation in Transport and Agriculture
- **Content Delivery Methods:**

  Chalk and talk, Power point presentation

- **Assessment Methods:**
  Theoretical questions

Text Books:-

1. J.B. Gupta, “A course in Electrical Power” by, S K Kataria And Sons
2. Dr. S.L. Uppal, “Electrical power”, Khanna Publishers **References:-**
1. B.R. Gupta, “Generation of Electrical Energy”, S Chand
2. E. O. Taylor, “Utilizations of electrical energy”, Orient Longman Pvt Ltd.
3. H Partab, “Art & Science of Utilization of Electrical Energy” Dhanpat Rai & Co

Internal Continuous Assessment (ICA):-

There should be minimum 6 assignments on the above syllabus and one industrial visit.
Visit to any one location from the following-

1. Railway station (Control room)
2. Loco shed
3. Traction substation

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SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-II
Power Electronics

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week,4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25Marks
	ISE- 30Marks
	POE: 50 Marks

Course prerequisite:
Basics of low power Semiconductors devices, rectifiers, AC, DC waveforms and its equations

Course Objectives

1) To make student analyze the various power electronic devices.
2) To make student to analyze the various power conversion techniques.
3) To enhance the analytical ability of the students in industrial application of power electronics.

Course Outcome:
After successful completion of this course
1) Students will be able to analyze the various power electronic devices.
2) Students will be able to analyze various power conversion techniques.
3) Students will be able to analyze industrial application of power electronics.

SECTION I

Unit 1 Switching devices **No of Lectures - 13**

- **Prerequisite:**
  Low power Semiconductor diode, transistor and MOSFET

- **Objective:**
  To make student, analyze the various power electronic devices.

- **Outcome:**
  Students will be able to analyze the various power electronic devices.

- **Unit Content**:
  Introduction to Power Diode, Principle of operation of Silicon Controlled Rectifier (SCR), Static & Dynamic characteristics, Gate Characteristic, Turn on Methods, Firing circuits (using R, R-C, UJT), Commutation Circuits (class A to F), Protection circuits of SCR (over voltage, over current, dv/dt & di/dt).Specification and ratings. Principle of operation, V-I characteristics, rating and applications of Triac, Diac, Gate turn Off Thyristor (GTO), Power MOSFET, Insulated Gate Bipolar Transistor (IGBT), need for gate drive circuits.

- **Content Delivery Method**:
  Chalk and Talk, Power Point Presentation, Animation Video

- **Assessment Methods**:
  Objective, subjective and derivation questions.

Unit 2 Controlled Rectifiers **No of Lectures - 13**

- **Prerequisite:**
  Low Power diode based rectifiers.

- **Objective:**
  To make student, analyze the Controlled rectifier circuit as one of power conversion techniques

- **Outcome:**
  Students will be able to analyze Controlled rectifier circuit as one of power conversion techniques.

- **Unit Content**
  Introduction, Half wave controlled rectifiers with R, R-L load with and without freewheeling diode, Full Wave controlled rectifiers (Half controlled & Fully controlled) with R, R-L load with and without freewheeling diode, Three phase half controlled & Fully controlled rectifiers with R load.

- **Content Delivery Method**:
  Chalk and Talk, Power Point Presentation, Animation Video

- **Assessment Methods:**
  Objective, subjective, derivation and Numerical questions.

SECTION- II

Unit 3 DC to DC converters **No of Lectures - 8**

- **Prerequisite:**
  Operation of Switching devices, concept of duty cycle.

- **Objective:**
  To make student, analyze the DC to DC converter circuit as one of power conversion techniques.

- **Outcome:**
  Students will be able to analyze DC to DC converter circuit as one of power conversion techniques.

- **Unit Content**
  Principle of operation of chopper, Classification of choppers, Commutation circuits for chopper, Control Techniques, Step down and Step up choppers, DC-DC switched mode regulators– Buck, Boost, Buck-Boost and Cuk.
- **Content Delivery Method**:
  Chalk and Talk , Power Point Presentation, Animation Video

- **Assessment Methods**:
  Objective, subjective, derivation and Numerical questions

Unit 4 Inverters **No of Lectures - 10**

- **Prerequisite:**
  Operation of Switching devices, pure and quasi AC waveforms**.**

- **Objective:**
  To make student, analyze the DC to AC converter circuit, as one of power conversion techniques

- **Outcome:**
  Students will be able to analyze DC to AC converter circuit, as one of power conversion techniques

- **Unit Content**
  Introduction and Classification of Inverters, Principle of operation, Performance parameters, Single phase half and full bridge Inverters, 3 phase bridge Inverters (120^0 and 180^0 conduction mode) with R & R-L load, Voltage control methods of 1 phase inverters, Harmonic reduction techniques.

- **Content Delivery Method:**
  Chalk and Talk, Power Point Presentation, Animation Video

- **Assessment Methods**
  Objective, subjective, and Numerical questions.

Unit 5 AC Voltage Controllers: **No of Lectures - 04**

- **Prerequisite:**
  Operation of switching devices ie SCR and Triac, AC waveforms**.**

- **Objective:**
  To make student, analyze the AC to AC converter circuit, as one of power conversion techniques

- **Outcome:**
  Students will be able to analyze AC to AC converter circuit, as one of power conversion techniques

- **Unit Content**
  Introduction of AC Voltage Controllers, Principle of On-Off Control, Principle of Phase Control, Single Phase bidirectional control with R & R-L load.

- **Content Delivery Method:**
  Chalk and Talk, Power Point Presentation, Animation Video

- **Assessment Methods**:
  Objective, subjective, and Numerical questions.

Unit 6 Applications of power electronics: **No of Lectures - 04**

- **Prerequisite:**
  Various power conversion techniques.

- **Objective:**
  To enhance the analytical ability of the students in industrial application of power electronics.

- **Outcome:**
  Students will be able to analyze industrial application of power electronics.
- **Unit Content**

  Speed control of electric motor, Switched mode power supply (SMPS), Uninterrupted Power Supply (UPS), Power Electronics for Renewable Energy Sources, Automotive Applications of Power Electronics.

- **Content Delivery Method:**
  Chalk and Talk, Power Point Presentation, Animation Video

- **Assessment Methods**
  Subjective questions

Text Books:

1. M H Rashid, "Power Electronics" Prentice-Hall of India
2. P S Bimbhra, "Power Electronics" Khanna Publishers
3. K Hari Babu, "Power Electronics" Scitech Publication
4. Alok Jain, "Power Electronics & its Applications" Penram International Publishing (India) Pvt. Ltd.
5. Vedam Subramanyam, "Power Electronics" New Age International

Reference Book:

1. Landers "Power Electronics", McGraw Hill
2. M.D. Singh, K.B. Khanchandani, "Power Electronics" Tata McGraw Hill
3. P.C.Sen, "Modern Power Electronics" Wheeler Publication
4. M H Rashid , "Power Electronics Handbook" Academic Press Series in Engineering .

.Internal Continuous Assessment (ICA):

Minimum **Five** experiments and **Three** simulations should be performed in the laboratory:

List of experiment is as follows:
1. V-I Characteristic of SCR
2. Characteristic of any one high switching frequency devices
3. Commutation circuit of SCR
4. Experiment based on controlled rectifiers
5. Experiment based on inverters
6. Experiment based on DC to DC converter
7. Experiment based on AC voltage controller
8. Speed control of motors.

List of simulations is as follows:
1. Simulations based on AC to DC converter
2. Simulations based on DC to DC converter
3. Simulations based on DC to AC converter
4. Simulations based on AC to AC converter

SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-II
Control System-II

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week,4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25Marks
	ISE- 30Marks

- **Course Prerequisite:**
  Student shall have knowledge of Ordinary differential equation, mathematical modeling of different systems, transient and steady state response of systems, stability of systems in time domain and frequency domain. Student shall also have basic knowledge of linear algebra and Laplace and Z-Transform.
- **Course Objectives**
  1) To enhance the analytical ability of the students in facing the challenges posed by growing trends in designing the control systems in time and frequency domain.
  2) To enhance the ability of the students to analyze and design the control system in modern control approach.
  3) To enhance the ability of the students to understand nonlinear control systems.
  4) To enhance the ability of the students to analyze the Discrete Time Control Systems.
- **Course Outcome**
  1) Students will be able to design the controller in time and frequency domain.
  2) Students will be able to analyze and design the control system in modern approach.
  3) Students will be able to analyze the nonlinear control systems.
  4) Students will be able to analyze the Discrete Time Control Systems.

SECTION I

Unit 1: Design of compensator using Root Locus **No of Lectures- 10**

- **Prerequisite:**
  Time domain specifications, stability, root locus plot
- **Objectives:**
  1) To revise root locus plot and stability analysis
  2) To make student understand different compensation techniques
  3) To make student design the compensators in time domain
  4) To make student realize the compensators
- **Outcomes:**
  After completing this chapter the student will be able to:
  1) Use the root locus to design cascade compensators to improve the steady-state error
  2) Use the root locus to design cascade compensators to improve the transient response
  3) Use the root locus to design cascade compensators to improve both the steady-state error and the transient response
  4) Realize the designed compensators physically

- **Unit contents:**
  Introduction of design problem, Approach & preliminary considerations, Realization of basic compensators with passive and active networks, Design of lead, lag & lag-lead compensators
- **Content Delivery Methods:**
  Chalk and talk, Video lectures and power point presentations
- **Assessment Methods:**
  Design problems and theoretical aspects

Unit 2: Design of compensator using Frequency response **No of Lectures- 6**

- **Prerequisite:**
  Frequency domain specifications, correlation between time and frequency domain, stability, Bode plot
- **Objectives:**
  1) To revise Bode plot and stability analysis
  2) To make student design the compensators in frequency domain
  3) To make student realize the compensators
- **Outcomes:**
  After completing this chapter the student will be able to:
  1) Use the Bode plot to design cascade compensators to improve the steady-state error
  2) Use the Bode plot to design cascade compensators to improve the transient response
  3) Use the Bode plot to design cascade compensators to improve both the steady-state error and the transient response
- **Unit Content:**
  Transient response through gain adjustment, lag compensation, lead compensation, lag-lead compensation using Bode Plot
- **Content Delivery Methods:**
  Chalk and talk, Video lectures and power point presentations
- **Assessment Methods:**
  Design problems and theoretical aspects

Unit 3: State-Space Analysis **No of Lectures- 10**

- **Prerequisite:**
  Introductory linear algebra, introductory differential equations and Laplace transform, introductory vector-matrix analysis
- **Objectives:**
  1) To introduce the basic methods of state variables and state equations
  2) To make student obtain the state space representation for electrical and mechanical systems
  3) Students can use state-space techniques to model linear systems
  4) Students understand the concepts of controllability and observability
- **Outcomes:**
  After completing this chapter the student will be able to:
  1) Find a mathematical model, called a state-space representation, for a linear, time invariant system

2) Model electrical and mechanical systems in state space
3) convert a transfer function to state space and vice versa
4) Controllability and observability

- **Unit Content:**
  Concept of state, state variable & state model, state-space representation of transfer function of electrical and mechanical systems, state transition matrix, its properties, Solution of homogeneous and non-homogeneous state equation, Controllability & Observability
- **Content Delivery Methods:**
  Chalk and talk, Video lectures and power point presentations
- **Assessment Methods:**
  Design problems and theoretical aspects

SECTION-II

UNIT 4: State Space Design **No of Lectures- 10**

- **Prerequisite:**
  Qualitative theory of ordinary differential equations, Linear algebra, State space representation and analysis
- **Objectives:**
  1) Understanding the basis results in state-space analysis of LTI systems
  2) Learn fundamental control design architectures
- **Outcomes:**
  After completing this chapter the student will be able to:
  1) Acquire knowledge of state space and state feedback in modern control systems, pole placement,
  2) Design pole placement controller and/or observer for the given system to achieve desired specifications
  3) Design of state observers and output feedback controllers
- **Unit Content:**
  Introduction, Design of Pole placement, Necessary and sufficient condition for arbitrary pole placement, Determination of K using transformation Matrix, Direct Substitution and Ackermann's Formula, State Observer, Full state observers , Effects of addition of the observer on a closed loop system. TF of the observer based controller Design of Control System with observers
- **Content Delivery Methods:**
  Chalk and talk, Video lectures and power point presentations
- **Assessment Methods:**
  Design problems and theoretical aspects

Unit 5: Non-linear Control Systems **No of Lectures- 10**

- **Prerequisite:**
  The students are expected to be familiar with ordinary differential equations, linear control systems and linear algebra

- **Objectives:**
  1) Learn properties of nonlinear behavior and nonlinear controlled systems
  2) Understand phase-plane analysis, equilibrium Points, describing function method
  3) Students will learn a variety of methods for analyzing the structure and behavior of nonlinear feedback systems.
- **Outcomes:**
  After the successful completion of the course the students will be able to:
  1) Construct the phase plane trajectory of a given nonlinear system
  2) Demonstrate non-linear system behavior by phase plane and describing function methods and the
  3) Identify the existence of limit cycle(s) for the given nonlinear system
  4) Perform the stability analysis nonlinear systems
- **Unit Content:**
  Introduction, common non-linearity in control system, Phase plane method. Singular points, Stability of Nonlinear Systems, construction of phase trajectories by analytical and graphical methods, Definition & derivation of Describing Functions for different non linearity
- **Content Delivery Methods:**
  Chalk and talk, Video lectures and power point presentations
- **Assessment Methods:**
  Design problems and theoretical aspects

UNIT 6: Discrete-time Control System **No of Lectures- 6**

- **Prerequisite:**
  Difference Equations, Z Transforms, Laplace Transforms, Linear Control System Analysis
- **Objectives:**
  1) To equip the students with the basic knowledge of discretization.
  2) To explain basic and digital control system for the real time analysis of control systems
  3) Explain the process of sampling and the effect of sampling period in the performance of digital control system
  4) Calculate the performance of a given pulse transfer function in time domain
- **Outcomes:**
  After completing this chapter the student will be able to:
  1) Derive discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain (transfer function using z-transform)
  2) Predict and analyze transient and steady-state responses of discrete-time control systems
  3) Analyze stability of open-loop and closed-loop linear, time-invariant, discrete-time control systems
- **Unit Content:**
  Basic elements of discrete data control system and its advantages over the continuous time system, Pulse Transfer Function of cascade elements, closed loop systems and digital controller, Z-transform analysis of Discrete-Time Control Systems, Mapping between s-

plane & z-plane, stability analysis of closed loop systems in z-plane using Juri's Test, Bilinear Transformation and Root Locus

- **Content Delivery Methods:**
  Chalk and talk, Video lectures and power point presentations
- **Assessment Methods:**
  Design problems and theoretical aspects

Text Books:

1. I. J. Nagrath, M. Gopal "Control System Engineering", 5th Edition. New Age International Publishers.
2. Control System Engineering by R Anandanatrajan, P Ramesh Babu, 2nd Edition, Scitech
3. Discrete-time Control Systems by K Ogata, Prentice Hall India, 2nd Ed
4. Digital Control Systems by B.C. Kuo, Saunders college Publishing, 2nd Ed

Reference Books:

1. Benjamin C. Kuo, "Automatic Control Engineering", Prentice Hall of India Pvt. Ltd.
2. K. Ogata, "Modern Control Engineering", Prentice Hall of India Pvt. Ltd.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988
4. Control system principles and design, M. Gopal, TMH publication, 3rd edition, 2008
5. Feedback Control Systems, C. L. Phillips, R. D. Harbor PHI publication, 1988

Internal Continuous Assessment (ICA):
Minimum **eight** programs should be performed in the laboratory based on the entire syllabus.

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SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-II
Signals & Systems

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week,4 Credits	**ESE –** 70 Marks
Tutorial: - 1 Hr/Week, 1 Credit	**ICA-**25Marks
	ISE- 30Marks

This course covers the fundamentals of signals viz. representations, types and operations on it; and different types of systems and its properties. It also introduces analysis of discrete time and continuous time linear time-invariant systems in time domain and frequency. It includes concepts of computationally efficient algorithms viz. DIFFFT and DITFFT.

Course Prerequisite:

Student shall have mathematical background of differential equations, differentiation and integration. He/She shall also have basic knowledge of Z transform.

Course Objectives:

1. To make student understand mathematical descriptions and representations of continuous and discrete signals & systems.
2. To make student understand the types of basic signals, its transformations, concept of convolution, systems and it's properties
3. To make student understand the use transforms techniques for the analysis of LTI systems.
4. To make student understand the concept and applications of Discrete Fourier Transform and Z transform.

Course Outcomes:

At the end of the course student is able to -

1. Analyze mathematical descriptions and representations of continuous and discrete signals & systems.
2. Identify types of basic signals, its transformations, concept of convolution, systems and it's properties
3. Analysis of transforms techniques of LTI systems.
4. Apply the Discrete Fourier Transform and Z transform for practical approach.

SECTION-I

Unit 1: Introduction to Signals **No of Lectures- 10**

- **Prerequisite:** Basic Mathematics
- **Objectives:**
  1. To introduce to student different class of signals.
  2. To make student perform signal transformations and arithmetic operations on continuous time & discrete time signals.

• **Outcomes:**

After completing this unit, student –

1. Is able to sketch and label different basic signals.
2. Can classify the given continuous time or discrete time signal into different classes such as even/odd, energy / power signals, periodic / non-periodic signals etc.
3. Can perform different transformations such as shifting, scaling & reversal on a given signal.
4. Can perform different arithmetic operations on given signals.
5. Can classify the given system represented by input / output relation into different types such as static/dynamic, linear/nonlinear, causal/non causal, stable/unstable, time invariant/ time variant etc.

• **Unit Content:**

Definition of signals; Classification of signals: Continuous time and discrete time, the different types of basic continuous signals(Unit step, Unit Impulse, Exponential, Sinusoidal, Unit ramp), Elementary Discrete time signals (Unit step, Unit Impulse, Exponential, Sinusoidal, Unit ramp), Properties of Unit Impulse, Operations on signals: time shifting, time reversal, Amplitude scaling, time scaling, signal addition & subtraction, signal multiplication Properties of CT & DT signals (Periodic, non-periodic, Even and Odd signals, Causal-Noncausal, Deterministic & Non-deterministic), energy and power of Continuous time signal and discrete time signal, Even and odd components of signals

• **Content Delivery Methods:**

Chalk and talk, power point presentations

• **Assessment Methods:**

Different types of signals, signal transformations, classification of signals (numerical approach)

Unit 2: Introduction to Systems **No of Lectures- 06**

- **Prerequisite:** Basic Mathematics
- **Objectives:**

  To introduce to student different types of systems based on system properties.

• **Outcomes:**

After completing this unit, student can classify the given system represented by input / output relation into different types such as static/dynamic, linear/nonlinear, causal/non causal, stable/unstable, time invariant/ time variant etc.

• **Unit Content:**

Definition of system, Classification: Continuous time signal and discrete time systems, lumped parameter and distributed parameter systems, static and dynamic systems, causal and non-causal systems, linear and nonlinear systems, time variant and invariant systems, stable and unstable systems, invertible & noninvertible systems.

• **Content Delivery Methods:**
Chalk and talk, power point presentations
• **Assessment Methods:**
Numerical related to System properties.

Unit 3: Linear Time-Invariant Systems **No of Lectures- 10**

•**Prerequisite:** Basic signals, properties of signals & systems

• **Objectives:**
1. To make student understand representation of continuous time signals & discrete time signals in terms of unit impulse signal.
2. To make student understand the convolution operation.
3. To compute the convolution sum / integral of given signals.

• **Outcomes:**
After completing this unit, student is able to–
1. Compute the convolution sum/ Integral of given signals.
2. Identify the system properties of given impulse response of the system.

• **Unit Content:**
Introduction, Representation of discrete time signals in terms of impulse, Impulse response, Response of DT-LTI system: Convolution sum (Graphical & Analytical method), Response of CT-LTI systems: Convolution Integral, Properties of convolution Properties of DT-LTI system (Dynamicity, invertibility and inverse DT-LTI system, Causality, stability, unit step response), Properties of CT-LTI system (Dynamicity, invertibility and inverse CT-LTI system, Causality, stability, unit step response), Singularity functions.

• **Content Delivery Methods:**
Chalk and talk, power point presentations
• **Assessment Methods:**
Convolution sum / integral computation, properties of convolution, Properties of DT-LTI system, Properties of CT-LTI system

Section-II

Unit 4: Z Transform **No of Lectures- 09**

•**Prerequisite:**

Understanding of basic signals, Geometric Progression & basic mathematics

• **Objectives:**
1. To make student understand need & z domain representation of time domain DT signals.
2. To make student understand the Region of convergence of Z transform.
3. To compute the response of DT LTI system using Z transform approach.

• **Outcomes:**
After completing this unit, student –
1. Is able to state the need of Z transform in analysis of DT systems.
2. Is able to identify the Region of Convergence of Z transform.
3. Is able to compute the response of DT LTI system using Z transform.

• **Unit Content:**

Z -transform: Z transform & region of convergence of finite and infinite duration DT signals. Properties of region of convergence. Properties of Z transforms (Statement, Proof and Numerical): Linearity, Time scaling, Time Shifting, Convolution, differentiation (Multiplication by 'n'), Initial value theorem, Final value theorem.

Inverse Z transform: Power series method, Partial fraction expansion method, Residue method

Application of Z transform: Transfer Function, Pole zero plot, Stability.

• **Content Delivery Methods:**

Chalk and talk, power point presentations

• **Assessment Methods:**

Proofs of Z transform properties, Numerical on Z and inverse Z transform.

Unit 5: Fourier Transform **No of Lectures- 09**

•**Prerequisite:**

Understanding of basic signals & basic mathematics

• **Objectives:**

To make student understand analysis of aperiodic signals.

• **Outcomes:**

After completing this unit, student is able to analyze aperiodic signals.

• **Unit Content:**

Continuous time Fourier transform:

Introduction, Convergence of Fourier transform, phase and magnitude spectrum, Properties (Statement, Proof & Numericals): Linearity, Time shifting, Frequency shifting, time scaling, frequency differentiation, time differentiation, convolution.

Discrete time Fourier transform:

Introduction, Relation between Z transform and DT Fourier transform, existence of DT Fourier transform, Properties (Statement, Proof & Numericals): Linearity, Periodicity, Time shifting, Frequency shifting, time reversal, differentiation, convolution in time domain, convolution in frequency domain and Parsevals theorem.

• **Content Delivery Methods:**

Chalk and talk, power point presentations

• **Assessment Methods:**

Proofs of Fourier transform properties, Numerical on CT and DT Fourier transform.

Unit 6: Discrete Fourier Transform **No of Lectures- 08**

•**Prerequisite:**

Understanding of basic signals, Geometric Progression & basic mathematics

• **Objectives:**

To make student understand analysis of signals in time and frequency domain.

• **Outcomes:**

After completing this unit, student is able to analyze signals in time and frequency domain.

• **Unit Content:**

Discrete Fourier Transform:

Introduction, 4 & 8 point DFT & IDFT, Properties: Linearity, Time shifting, Shift in K domain, Conjugate symmetry, Time reversal, linear convolution

Fast Fourier Transform:

Introduction, 8 point DITFFT algorithm and 8 point DIFFFT algorithm

• **Content Delivery Methods:**

Chalk and talk, power point presentations

• **Assessment Methods:**

Proofs of DFT properties, Numerical on DFT, IDFT and FFT algorithms.

Text Books:

1. Signals and Systems, A.V. Oppenheim, A. S. Wilsky, PHI Publication.
2. Signals and Systems, Simon Haykin, Barry Van Veen , John Wiley & Sons
3. Introduction to Analog and Digital Communications, Simon Haykins, Wiley India
4. "Signals and Systems", Dr. D.D. Shah & Prof. A.C. Bhagali, Mahalaxmi Publication Kolhapur

Reference Books:

1. M. J. Roberts and Govind Sharma, "Fundamentals of Signals and Systems",2nd edition,Mc Graw Hill,2010
2. Lathi B. P., "Signal & Systems", Oxford University press, 2nd Ed. 1998
3. Salivahan S., "Digital Signal Processing", TMH Publication, 2001.
4. A. Nagoor Kani, "Signals and Systems", McGraw Hill
5. P. Ramesh Babu & R. Anandanatarajan, "Signals and Systems", 4/e- SciTech
6. "Signals and Systems" Ghosh, Pearson Education.
7. "Signals, Systems and Transforms" Charles Phillips, Pearson Education, Third Edition,

Internal Continuous Assessment (ICA) :

Minimum **EIGHT** assignments based on the above syllabus

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SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-II
Electrical Machines Design

Teaching Scheme	Examination Scheme
Theory: - 4 Hrs/Week,4 Credits	**ESE –** 70 Marks
Practical: - 2 Hrs/Week, 1 Credit	**ICA-**25Marks
	ISE- 30Marks
	OE: 25 Marks

Course Prerequisite:
Knowledge on types, construction and working of transformers, DC Machines, three phase induction motor and Synchronous machines.

Course Objectives:

1. To get detailed knowledge of design of Transformers
2. To get detailed knowledge of design of DC Machines
3. To get detailed knowledge of design of Three phase Induction machines
4. To get detailed knowledge of design of Synchronous machines

Course Outcomes:

Upon successful completion of this course:

1. Student will be able to design transformer
2. Student will be able to design DC Machines
3. Student will be able to design Three phase Induction motors
4. Student will be able to design Synchronous machines.

SECTION-I

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Unit 1: Introduction: **No of Lectures- 6**

- **Prerequisite:**
  Working principle of DC and AC Machines
- **Objectives:**
  To make students to Understand design principle and modern trends in design of electrical machines
- **Outcomes:**
  After completion of this unit the learner will be able to-
  Understand design principle and modern trends in design of electrical machines
- **Unit Content:**
  Principles of design, design factors, specifications, limitations, modern trends in design of electrical machines
- **Delivery Methods:**
  Chalk and Talk
- **Assessment Methods:**

  Theoretical questions related to above contents

Unit 2: Design of transformers: **No of Lectures -10**

- **Prerequisite**:
  Transformer basics like Types, construction and working principle
- **Objectives:**
  1. To make students to Understand design of Transformers Parameters
  2. To make students to analyze Transformers Parameters
- **Outcomes:**
  After completion of this unit the learner will be able to
  1. Design core, yoke, windings, Tank and cooling systems of transformers
- **Unit Content:**
  Types, classification & specifications, output equation, design of core, selection of design constants, design of yoke, design of window, and design of windings, tank design with and without cooling tubes
- **Delivery Methods:**
  Chalk and Talk , Video lectures
- **Assessment Methods:**
  Theoretical questions related to above contents, Numericals on output equation, design of core, design of yoke, design of window, and design of windings, tank design with and without cooling tubes

Unit 3: Design of DC Machines **No of Lectures 10**

- **Prerequisite:**
  Basic knowledge of Rotating machines and Constriction, working of DC Machines
- **Objectives:**
  1. To make students to Understand design of rotating machines
  2. To make students to analyze DC Machine Parameters
- **Outcomes:**
  After completion of this unit the learner will be able to
  1. Analyze Design parameters of rotating machines
  2. Design of Poles, core length, air gap, and design of field system of DC Machines
- **Unit Content:**
  Output equations of DC machine, factors affecting size of rotating machines, Choice of specific loadings, separation of main dimensions, Selection of no of poles, core length, air gap, design of armature of field system
- **Delivery Methods:**
  Chalk and Talk, Video lectures
- **Assessment Methods:**
  Theoretical questions related to above contents, Numerical on output equation, specific loadings, Selection of no of poles, core length, air gap, design of armature of field system

SECTION-II

Unit 4: Design of three phase induction motors: **No of Lectures 13**

- **Prerequisite:**
  Basic knowledge of Constriction, Types and working of Three Phase Induction Motors
- **Objectives :**
  1. To make students to Understand design of three phase induction motors
  2. To make students to analyze three phase induction motors Parameters
- **Outcomes:**
  After completion of this unit the learner will be able to
  1. Design of Stator, rotor, windings of three phase induction motors
- **Unit Content:**
  Output equation, Choice of specific loadings, main dimensions, stator design, stator winding, stator core, stator slot design, selection of stator slots, air gap length, rotor design, selection of rotor slots, rotor bars/windings calculation, design of end ring, design of wound rotor, no of rotor turns, area of rotor conductors, rotor tooth density, design of rotor core.
- **Delivery Methods:**
  Chalk and Talk, Video lecture
- **Assessment Methods:**
  Theoretical questions related to above contents, Numerical on above contents

Unit 5: Design of synchronous machines: **No of Lectures 13**

- **Prerequisite:**
  Basic knowledge of Construction, Types and working of Synchronous machines
- **Objectives:**
  1. To make students to understand the design of Synchronous machines
  2. To make students to analyze Synchronous machines parameters
- **Outcomes:**
  After completion of this unit the learner will be able to
  Design of Main dimensions, length of air gap, armature, stator and rotor design of Synchronous machines
- **Unit Content:**
  Output equation, specific loadings, design of salient pole machines-main dimensions, length of air gap, armature design, design of turbo alternator main dimensions, length of air gap,stator design, rotor design.
- **Delivery Methods:**
  Chalk and Talk, Video lecture
- **Assessment Methods:**
  Theoretical questions related to above contents, Numericals on above contents

Text Books:

1. A.K Sawhney, “A course in Electrical machine design”, Dhanpat Rai & Sons
2. R.K Agarwal, “Principles of Electrical machine design” , S K Kataria & Sons

Reference Books:

1. Mittle V.N and Mittle A, “Design of Electrical machines”, Standard publications and Distributors
2. M.G.Say, “Performance & design of A.C machines”, CBS Publishers & Distributors
3. A.E.Clayton, “Performance & design of D.C machines”, CBS Publishers & Distributors

Internal Continuous Assessment (ICA):
Term work shall consist of at least 6 drawing sheets

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Self-Learning Module-II

SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-II
Module –I: Special Purpose Machines

Teaching Scheme	Examination Scheme
Theory: - 2 Credits	**ESE –** 50 Marks

This course introduces different special purpose machines in electrical engineering with their construction, working principle, operation, analysis and control techniques.

Course Prerequisite:

Student shall have knowledge of all conventional AC and DC machines.

Course Objectives:

1. To get detailed knowledge of construction, operating principles of different Special purpose machines
2. To find equivalent circuit parameters and performance parameters of all Special purpose machines
3. To understand different control methods and applications of different Special purpose machines

Course Outcomes:

Upon successful completion of this course,:

1. Student will be able to analyze performance of different Special purpose machines
2. Student will be able to examine performance of Special purpose machines.
3. Students will be able to identify applications of Special purpose machines.

Unit 1– Synchronous Reluctance Motors:
Introduction, Construction of Synchronous Reluctance Motor, Rotor design and construction, working of synchronous reluctance motor, primary design considerations, Torque – speed characteristics, Phasor diagram, Advantages and disadvantages, Applications

Unit 2– Stepping Motor:
Introduction, Classification of stepper motors, Single stack variable reluctance stepper motor (Construction, Connection and Principle of Operation), Micro stepping control of stepping motor, Multistack variable reluctance stepper motor, Hybrid stepper motor, Single phase stepping motor (Construction, Connection and Principle of Operation) , Static and Dynamic characteristics of stepper motor, Torque-speed characteristics, Drive system and control circuitry for stepper motor, Application of Stepper Motor.

Unit 3– Switched reluctance Motor:

Introduction, Construction and operation, Power semiconductor switching circuits,Voltage and torque equations, Control circuits, Torque-speed characteristics, Advantages and disadvantages, Applications.

Unit 4– Permanent Magnet Brushless D.C. Motors

Introduction, Constructional feature, Principle of operation, Classification, Emf equation, Torque equation, Torque- speed characteristics, Power and control circuit, Advantages and disadvantages, Applications.

Unit 5– Permanent Magnet Synchronous Motors

Introduction, Construction and principle of operation, Emf equation, Torque equation, Phasor diagram, torque-speed characteristics, Self-control, Vector control, Microprocessor based control

Text Books:

1. Electric Machines, Third Edition, Tata McGraw Hill Publication, I J Nagrath, D P Kothari
2. Electrical Machines, Third Edition, Tata McGraw Hill Publication, S K Bhattacharya
3. Theory and Performance of Electrical Machines, S K Kataria& Sons , J B Gupta
4. A Text Book of Electrical Technology Volume II, S Chand, B L Theraja
5. T.J.E.Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford..
6. T.Kenjo,'Stepping Motors and Their Microprocessor Controls', Clarendon Press London.

Reference Books:

1. Electrical Machinery, Sixth Edition 2002, Tata McGraw Hill, AEFitzgerald, CKingsley, SDUmans
2. Electrical Machinery, Khanna Publishers, P S Bhimbhra
3. Electrical Machines, Dhanpat Rai & Sons, Ashfaq Hussain
4. Theory and Performance of Electrical Machines, S K Kataria and sons, J B Gupta
5. Principles of electronic machines & Power electronics, Wiley India,P.C.Sen
6. R.Krishnan, 'Switched Reluctance Motor Drives–Modeling, Simulation, Analysis, Design and Application',CRC Press, NewYork

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Module - II – Electrical Safety

Teaching Scheme	Examination Scheme
Theory: - 2 Credits	**ESE –** 50 Marks

Prerequisite:

Knowledge of electrical standard and measurement

Course Objectives –

Student should understand safety precautions during working on electrical installations.

Course Outcome-

Students will get acquitted with Electrical safety procedures

Unit I: - Significance of safety management in electrical plants.
Objective of safety management, procedure of "work permit" at site to do work on electrical plant, equipment, auxiliaries.

Unit II: - Safety clearances and creepages.
Adquet clearances to be provides between phases, phase to earth, work section and live parts, isolating distance, etc.

Unit III:-Electrical shocks
Primary shocks & secondary shocks their occurrence, effect of electrical shocks on human body, safety precautions against electric shocks, recommendations for preventing electric shocks.

Unit IV:- First aid for a person who gets electric shock
Removal of contact with live conductor, methods of artificial respirations, safety procedures during erection phase, during commissioning phase, and during operation and maintenance phase.

Unit V:-Electrical fires
Cause of different type of electric fires, how do deal with fire on electrical installations, actions to be taken in case of fire, prevention of electric fires, types of extinguishers used.

Text books:-

1. Testing commissioning operation & maintenance of electrical equipments by S. Rao. Khanna Publication.
2. Installation commissioning & maintenance of electrical equipments by Trilok Singh S. K. Kataria & Sons.

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Module - III – Solar Photovoltaic System Design & Installation

Teaching Scheme	Examination Scheme
Theory: - 2 Credits	**ESE –** 50 Marks

Course prerequisite:

Basics of Electricity, Wires & Cables, Work, Power & Energy, Ohm's Law, Magnetism, Alternating Current, Power Generation, Distribution & Transmission.

Course Objectives

1) To make student to know solar photovoltaic.
2) To make student to understand components of solar PV system, types of solar photovoltaic systems.
3) To make student to understand components of installation tool kit and safety equipment
4) To make student to understand installation of components.

Course Outcome:
After successful completion of this course
1) Students will be able to know solar photovoltaic.
2) Students will be able to understand components of solar PV system, types of solar photovoltaic systems.
3) Students will be able to understand components of installation tool kit and safety equipment.
4) Students will be able to understand installation of components.

Unit 1 Introduction to Renewable and Solar Energy

Renewable Energy and its prospects various RE sources, Introduction to Solar Energy and Solar Radiation, its importance, Differentiate solar PV and solar thermal energy, Solar Resource, Measurement, Instrumentation and its applications.

Unit 2 Introduction of Photovoltaic Technology and its applications

Basics of Light to Energy Conversion, Brief History of Solar/PV cells, Physics of Energy Conversion in Solar Cell (Current and Voltage), Understanding basic terminologies of a PV cell (I-V Curve, efficiency, FF), Solar Cells to Module, Module name plate specifications, Module to Array and Basic Structure of PV module, Classification of PV Modules based upon technology, Brief on PV Cell/Module manufacturing process, Factors affecting output of a PV module (Temperature, Irradiance, Tilt angle, cell area, shadowing, dust, mismatch, PV module configurations, MPPT operation etc.), PV module defects and degradation in the field (Techniques for identification of defects), PV module Testing and Certification Standards, Applications of PV, different configurations of PV power system: Stand alone, Grid, hybrid system etc.

Unit 3 Components of a PV System: Battery, inverter and Charge controllers

Basics of standalone PV system, Balance of System (BOS), Introduction: Batteries, type of batteries, operation and structure, Basic Terminologies of a Battery, Charging & Discharging Characteristics, Factors affecting Battery operation and Selection Criteria, Testing standards for batteries, Introduction: Inverter, type of Inverters, operation, make and specifications, Basic Terminologies of a Inverter and Characteristics, Factors affecting inverter operation and Selection Criteria, Testing standards for inverters, Basics of Charge controllers, operation and specifications, DC-DC converters, Types of charge controllers and selection criteria, Components of a grid connected SPV system (ACB, DB and cabling), Types of wires and selection criteria, wire sizing. Other components like: Junction Box, Lighting arresters, grounding etc.

4 Fundamentals of PV system sizing

Sizing, significance and steps involved in sizing, Load Estimation, analysis and basics on energy efficiency, Site survey and assessment, Shading analysis, Customer profiling and Role play, Inverter, Battery sizing and its aspects, Module sizing and its aspects. Lay out diagrams, Spacing of PV strings and placing of each component, Selection of modules, batteries and inverters from the market specifications, Various steps involved in sizing of grid connected PV systems, Introduction to single line diagram and its significance, Listing of various components required for a grid connected and stand alone Solar power plant. (A check list of Each and every component), Understanding of various costs (Project heads) involved in the solar projects.

Unit 5 Installation of Solar Power plant

Preparation and general considerations for installation (DC and AC components), Installation of Array support structure and mounting of PV modules, Interconnection of modules, strings and Combiner boxes, Installation of other System components, i.e. Inverter, battery etc, Installation of AC and DC power distribution boxes, General safety consideration in the installation phase of solar power plant.

Text Books:

1. Solar Electricity Handbook - 2014 Edition: Michael Boxwell
2. Photovoltaics: System Design and Practice 1st Edition by Heinrich Häberlin
3. Solar PV Installer: Handbook

Reference Book:

1. Photovoltaics: Design and Installation Manual 1st Edition
2. The Ultimate Solar Power Design Guide by Lacho Pop, Dimi Avram

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Module - IV – Instrumentation Process Control & Robotics

Teaching Scheme	Examination Scheme
Theory: - 2 Credits	**ESE** – 50 Marks

Course Prerequisite:
Basic control systems, controllers,
Course Objectives
1) To differentiate between manipulating variable and disturbance
2) To explain the effect of P-D controller
3) To explain the terms: Auto Tuning, Bumpless Transfer and Integration Wind Up
4) To explain a scheme for implementation of P-I-D controller using electronic circuit
5) To justify the use of feedforward controller in addition to conventional feedback controller
Course Outcome
At the end of this lesson, the student should be able to
1) Develop linearised mathematical models of simple systems
2) Write the input-output relationship of a P-I-D controller
3) Explain the importance of tuning of controller for a particular process
4) Distinguish between position algorithm and velocity algorithm for implementation of digital P-I-D controller
5) Find the transfer function of the feed forward controller for complete disturbance rejection

Unit 1: Introduction to Process Control
Introduction to Process Control, P-- I -- D Control, Controller Tuning, Implementation of PID Controllers
Unit 2: Special Control Structures
Feed forward and Ratio Control, Predictive Control, Control of Systems with Inverse Response
Unit 3: State-Space Analysis
Cascade Control, Overriding Control, Selective Control, Split Range Control

Unit 4: Robotics
Robot anatomy-Definition, law of robotics, History and Terminology of Robotics, Accuracy and repeatability of Robotics
Unit 5: Elements of robots – links, joints, actuators, and sensors
Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge based force-torque sensors, proximity and distance measuring sensors, and vision
Unit 6: Kinematics of serial robots
Introduction, Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems

- **Text Books:**

1. Stephanopoulos, “Chemical Process Control, 2nd edition, Prentice Hall, New Delhi, 2003.
2. Coughanowr, “Process Systems Analysis and Control”, 2nd Edition, McGraw Hill, Singapore, 1991.
3. Peter Harriott, “Process Control”, Tata McGraw Hill, New Delhi, 1985.
4. Ghosal, A., Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2nd reprint, 2008.
5. Fu, K., Gonzalez, R. and Lee, C. S. G., Robotics: Control, Sensing, Vision and Intelligence¸ McGraw- Hill, 1987.

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SOLAPUR UNIVERSITY, SOLAPUR
T.E. Electrical Engineering Semester-II
Mini Hardware Project

Teaching Scheme	Examination Scheme
Practical: - 2 Hr/Week **,** 1 Credit	**ICA –** 25 Marks
	OE-25 Marks

Objectives:

- To Fulfill the needs of society in solving technical problems using engineering principles, tools and practices, in an ethical and responsible manner
- To acquire practical knowledge of new technologies for project development
- To work in fields such as design, research, testing and manufacturing
- To work in a team in development of technical projects

Outcomes:

After successful completion of this project student will be able to:

- acquire practical knowledge within the chosen area of technology for project development
- contribute as an individual or in a team in development of technical projects
- develop effective communication skills for presentation of project related activities
- identify, analyze, formulate and handle programming projects with a comprehensive and systematic approach

1) Project group should consist of students not more than 4 students

2) The group should submit a synopsis of the project to the department.

3) A group should complete the project in this semester.

4) The term work marks should be based on preparation of project work completed.

Note: Students groups should study and fabricate at least one mini hardware project such as but not restricted to the following

- Power supply
- Circuit using various types of transducer.
- Circuit using various sensors
- Circuit using various electronic and mechanical limit switches.
- Model project of electrical system.
- Circuit based on microprocessor application.
- Constructing and testing of simple power electronic circuit.
- Circuit based on PLC.

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