16EE302 POWER SYSTEM ANALYSIS

Hours Per Week :

L	T	P	C
3	1	-	4

Total Hours :

L	T	P
45	15	-

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	5	8	5	5

Course Description and Objectives:

This course offers comprehensive knowledge on the basics of power system and its operation under steady state and transient state. The objective of the course is to model the power system and analyze power flow, different types of faults and stability using numerical techniques.

Course Outcomes:

The student will be able to:

- model different components in power system.
- obtain the system matrices used for various analysis.
- perform steady state load flow analysis.
- analyze symmetrical and unsymmetrical faults.
- analyze steady state and transient stability limits.

SKILLS:

- ✓ *Understand power system network model.*
- ✓ *Formulate basic power flow problem.*
- ✓ *Apply different numerical techniques to solve power flow problem.*
- ✓ *Perform contingency analysis in power system.*
- ✓ *Classify different short circuit faults in power systems.*
- ✓ *Understand the stability problem in power system subjected to disturbances.*

ACTIVITIES:

- *Building Y bus algorithm using MATLAB.*
- *Building Z bus algorithm using MATLAB.*
- *Solving non algebraic equations using Gauss Seidel's method.*
- *Solving non algebraic equations using newton's Raphson method.*
- *Solution of Swing equation for a given change in load.*

UNIT - 1 **L-10, T-3**

GRAPH THEORY AND NETWORK MATRICES: Review of graph theory, Network incident matrices, Formation of system Y-bus by inspection and by singular transformation, Z-bus building algorithm without mutual coupling, Formation of Y-bus and Z-bus matrices for simple power system.

UNIT - 2 **L-10, T-3**

POWER FLOW PROBLEM - I : Formulation of power flow problem - Types of buses, Classification of variables, Expressions for real and reactive power injections through Y-bus elements; Iterative solution using Gauss-Seidel method - Flow chart and algorithm incorporating Q-limit check for voltage-controlled buses; Solution of a set of non-linear algebraic equations by Newton's method - Convergence of solution, Algorithm and flow chart; Numerical solutions of systems upto 3-buses.

UNIT - 3 **L-8, T-3**

POWER FLOW PROBLEM - II : Decoupled Newton load flow - Assumptions, Derivation, Algorithm and flow chart; Fast decoupled load flow - Assumptions, Derivation, Algorithm and flow chart; Numerical solution of systems up to 3-buses; Comparison of all load flow methods.

UNIT - 4 **L9, T-3**

FAULT ANALYSIS: Single line diagram – Per phase and per unit representation, Change of base; Reactances of synchronous machine under steady and transient conditions, Symmetrical fault analysis - Fault level and circuit breaker capacity; Review of symmetrical components, Unsymmetrical fault analysis, Build Positive, Negative and Zero sequence networks for different faults, Numerical problems.

UNIT - 5 **L-8, T-3**

STABILITY ANALYSIS:

Steady state stability: Introduction to steady state, Dynamic and transient stability of synchronous machine connected to infinite bus, Power angle curve, Swing equation, Small signal oscillations, Synchronizing power coefficient.

Transient stability: Equal area criterion, Computation of swing curve by point-by-point solution, Case studies, Introduction to computation of swing curve by numerical methods.

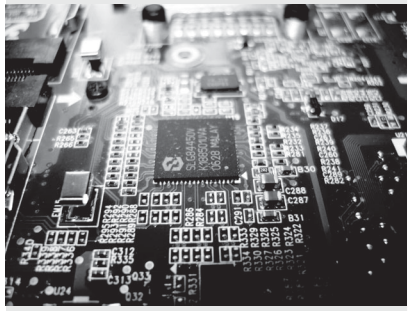
TEXT BOOKS:

1. J. Grainger and WD Stevenson Jr, "Power System Analysis", 1st edition, Tata Mc-Graw Hill Publishing Company Ltd., New Delhi, 2005.
2. D.P. Kothari, I.J. Nagrath, "Modern Power System Analysis", 3rd edition, Tata Mc-Graw Hill Publishing Company Ltd., New Delhi, 2008.

REFERENCE BOOKS:

1. Hadi Saadat, "Power System Analysis", 1st edition, Tata Mc-Graw Hill Publishing Company Ltd., New Delhi, 1999.
2. O I Elgerd, "Electric Energy Systems Theory an introduction", 2nd edition, Tata Mc-Graw Hill Publishing Company Ltd., New Delhi, 2006.
3. P. Kundur, "Power System Stability and Control", 1st edition, Mc-Graw Hill, 2009.

16EE304 MICROPROCESSOR ARCHITECTURE AND CONTROL



Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	-	8	5	-

Course Description and Objectives:

This course deals with the basic architecture, assembly language programming, pin definitions, supporting chips and memory interfacing of microprocessors and microcontrollers. The objective of the course is to understand various addressing modes, different peripheral devices and their interfacing with 8086 and 8051.

Course Outcomes:

The student will be able to:

- explore the architecture of microprocessors and microcontrollers.
- select a microprocessor or a microcontroller suitable for the given application.
- write assembly language program in 8086 and 8051 for various applications.
- create necessary memory and I/O interfacing with 8086 and 8051.

SKILLS:

- ✓ *Write assembly language program for 8086 and 8051.*
- ✓ *Debug assembly language programs.*
- ✓ *Make working I/O inerfaces.*
- ✓ *Develop application programs for 8 bit and 16 bit processors / controllers.*

ACTIVITIES:

- *Interface a 16x2 LCD with 8051.*
- *Interface a 4X4 Hex keypad with 8051.*
- *Interfacing a Stepper motor.*
- *Interfacing DAC: to generate Square and Triangular waves.*
- *Interfacing ADC: to convert analog signal to digital and to display it in 7-segment LED display.*
- *With the help of timer units in 8051 Count external pulses arriving on port pins.*
- *Design any microcontroller based system with more than seven peripherals.*

UNIT – 1

L-9

INTRODUCTION TO MICRO COMPUTER SYSTEM AND 8-BIT MICROPROCESSORS: Block diagram representation of microcomputer system / microprocessors and the role of various functional units, 8085 Microprocessor architecture, Clock, Memory, Bus systems, Pin description, Interrupts and Instruction set, Programming of 8085.

UNIT – 2

L-10

16-BIT MICROPROCESSORS: 8086 microprocessor architecture, Signals, Modes of operation, Instruction set, Addressing modes, Assembler directives, Procedures, Macros, Interrupts, Programming of 8086.

UNIT – 3 **L-8**

INTERFACING WITH 8086: Memory interfacing with 8086, I/O interfacing with 8086, 8255 PPI architecture, Modes, Interfacing of different I/O devices (LEDs, Display units, ADC,DAC, Stepper motor) using 8255, Basic architecture of 8259 interrupt controller, 8257 DMA controller and their applications.

UNIT – 4 **L-9**

MICRO CONTROLLERS: Architecture of 8051 microcontroller, Signals, I/O ports, Memory, Counters, Timers, Serial data I/O, Interrupts, Addressing modes, Instruction set and simple programs for 8051.

UNIT – 5 **L-9**

I/O INTERFACING WITH MICRO CONTROLLER: Programming 8051 - Timers, Serial port and Interrupts programming; LCD interfacing, ADC, DAC, Sensor interfacing, Stepper motor interfacing.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours: 30

1. Programs on Data Transfer Instructions
2. Programs on Arithmetic and Logical Instructions
3. Programs on Branch Instructions
4. Programs on Subroutines
5. Sorting of an Array
6. Programs on Interrupts (Software and Hardware)
7. Programs using DOS and BIOS Interrupts
8. Reading, Displaying of characters.
9. String operations: Moving, Reversing, Comparing, Scanning strings.
10. Interfacing DAC: to generate Square, Triangular, Ramp, Staircase waves.

TEXTBOOKS:

1. A. K. Ray and K.M. Bhurchandani, “Advanced Microprocessors and Peripherals”, 2nd edition, Tata Mc-Graw Hill, 2012.
2. Kenneth J. Ayala, “The 8051 Microcontroller – Architecture, Programming and Applications”, 3rd edition, Cengage Learning India Pvt. Ltd.,2008.

REFERENCE BOOKS:

1. Douglas V.Hall, ”Microprocessors and Interfacing”, Tata Mc-Graw Hill, 3rd edition, 2010
2. Liu and GA Gibson, “Micro Computer System 8086/8088 Family Architecture Programming and Design “, Prentice Hall of India, 2nd edition, 2010.
3. Myke Predko, “Programming and customizing the 8051 Microcontroller”, Tata Mc-Graw Hill, New Delhi - 2nd edition, 2011.
4. Barry B. Brey, “The Intel microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro processor, Pentium II, Pentium III, Pentium 4, and Core2 with 64-bit extensions:architecture, programming, and interfacing”, 8th edition, Pearson Prentice Hall, 2009.
5. Mohamed Rafiquzzaman, ”Microprocessors and Microcomputer Based System Design”, 2nd edition, CRC Press, 2007.

16EE306 SWITCH GEAR AND PROTECTION

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	-	8	5	2

Course Description and Objectives:

This course introduces basic concepts of Relays, Protection schemes, Switch gear and Modern trends in protection of power system equipments. The objective of the course is to understand the operation and application of power system protection equipments such as relays, circuit breakers and fuses; master various protection schemes for generators, transformers and transmission lines against faults.

Course Outcomes:

The student will be able to:

- understand the working of different types of switchgear equipments like circuit breakers and relays.
- specify the ratings for fuses according to application.
- elucidate various protection schemes for various power system components like alternators, transformers and bus-bars.
- understand various methods of over voltage and over current protection in power systems.

SKILLS:

- ✓ *Draw line diagram of substation.*
- ✓ *Identify various types of faults in power system.*
- ✓ *Identify proper settings for relays to protect a given equipment.*
- ✓ *Suggest the protection schemes for alternator, transformers and busbars.*
- ✓ *Create and manage safe and reliable switch gear system.*

UNIT – 1

L-9

INTRODUCTION TO POWER SYSTEM PROTECTION: Importance and requirements of protective system, Overview of switchgear equipments.

CIRCUIT BREAKERS: Elementary principles of arc interruption, Recovery, Restricking voltage, Restricking phenomenon, Average and maximum RRRV, Numerical problems, Current chopping and resistance switching, CB ratings and specifications, Auto reclosures.

DESCRIPTION AND OPERATION OF CIRCUIT BREAKERS: Structure and working of minimum oil circuit breakers, Air blast circuit breakers, Vacuum and SF6 circuit breakers.

UNIT – 2

L-9

ELECTROMAGNETIC AND STATIC RELAYS : Principle of operation and construction of attracted armature, Balanced beam, induction disc and Induction cup relays.

RELAYS CLASSIFICATION: Characteristics of instantaneous, DMT and IDMT, Over current relays, Direction relays, Differential relays and percentage differential relays, Universal torque equation.

DISTANCE RELAYS: Characteristics of impedance, Reactance and Mho type distance relays and their comparison.

STATIC RELAYS: Construction of static relays and compare with electromagnetic relays.

UNIT – 3 **L-9**

FUSES: Desirable characteristics of fuse elements, Terminologies associated with fuse, Types of fuses, HRC fuse.

FEEDER AND BUS-BAR PROTECTION : Protection of lines using over current, Carrier current and three-zone impedance type distance relays, Translay relay, Protection of bus bars, Differential protection.

NEUTRAL GROUNDING : Grounded and ungrounded neutral systems, Methods of neutral grounding - Solid, Resistance, Reactance; Arcing grounds and grounding practices.

UNIT – 4 **L-9**

GENERATOR PROTECTION : Protection of generators against stator faults, Rotor faults and abnormal Conditions, Restricted earth fault and Inter-turn fault protection, Numerical problems on percentage winding unprotected.

TRANSFORMER PROTECTION : Percentage differential protection, Numerical problem on design of CT Ratio, Buchholtz relay.

UNIT – 5 **L-9**

PROTECTION AGAINST OVER VOLTAGES : Generation of over voltages in power systems, Protection against lightning over voltages - Valve type, Zinc-Oxide lightning arresters; Insulation co-ordination, BIL, Impulse ratio, Standard impulse test wave, Volt-time characteristics.

TEXT BOOKS:

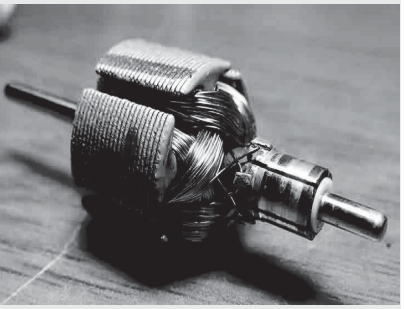
1. Sunil S. Rao, “Switchgear and Protection” 12th edition, Khanna Publlishers, 2007.
2. Badari Ram, “Power System Protection and Switchgear” 1st edition, D.N Viswakarma, Tata Mc-Graw Hill, Publications, 2005.

REFERENCE BOOKS:

1. T S Madhav Rao, “Power System Protection : Static Relays”, 2nd edition, Tata Mc-Graw Hill, 2007.
2. CL Wadhwa, “Electrical Power Systems”, 4th edition, New Age international (P) Limited, 2008.
3. Paithankar and S.R.Bhide., “Fundamentals of Power System Protection” 1st edition, Prentice Hall of India, 2007.

ACTIVITIES:

- *Visit a substation and prepare it’s technical report on control side.*
- *Check the polarity of CT and PT and connect it with relay.*
- *Find the fusing factor of a given fuse material.*
- *Test over-load relay and plot time current characteristics.*
- *Test static relay for protection of motor.*
- *Set up a horn gap lightning arrester.*



16EE308 SYNCHRONOUS AND SPECIAL MACHINES

Hours Per Week :

L	T	P	C
3	-	2	4

Total Hours :

L	T	P
45	-	30

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	-	8	5	5

Course Description and Objectives:

This course deals with the construction, operation and applications of synchronous machines and special machines such as hysteresis, repulsion, AC series, variable reluctance, permanent magnet and stepper motors. The objective of course is to understand the complete characteristic features of different synchronous machine and special machines in their field of applications.

Course Outcomes:

The student will be able to:

- understand the operational characteristics of alternators.
- analyze power factor correction capability of synchronous motor.
- analyze starting and running characteristics of single phase induction motor.
- understand the suitability of special machines for given application.

SKILLS:

- ✓ *Obtain the voltage regulation of alternator at any given load.*
- ✓ *Synchronize alternator to supply mains.*
- ✓ *Choose a single phase induction motor for the given application.*
- ✓ *Choose an appropriate special machine for given application.*

UNIT - 1 **L-10**

CONSTRUCTIONAL FEATURES OF ALTERNATORS: Construction - Revolving field type, Rotating armature type, Salient pole and non-salient pole field structure, Principle of operation; Relation between speed and frequency of alternator, Methods of cooling.

ARMATURE WINDINGS: Single layer, Double layer, Full and fractional pitch windings, Pitch factor, distribution factor, Expression for induced emf, Harmonics and their reduction.

LOAD CHARACTERISTICS: Voltage regulation, Causes - Effective resistance, Leakage reactance, Armature reaction, Synchronous reactance; Open circuit and short circuit tests, Phasor diagrams.

UNIT - 2 **L-9**

METHODS OF PREDICTING REGULATION : EMF method, MMF method, Potier triangle method and ASA method.

SALIENT POLE GENERATOR : Two reaction theory - Direct and quadrature axes synchronous reactance; Slip test, Phasor diagrams, Regulation.

ALTERNATOR UNDER SHORT CIRCUIT : Armature current oscillograms on sudden short circuit, Determination of sub transient and transient reactances.

UNIT - 3 **L-9**

PARALLEL OPERATION : Methods of synchronization, Circulating current, Synchronizing power, Effect of change in excitation, Effect of change in prime mover torque, Influence of governors on load division between parallel units, Hunting of alternators.

UNIT - 4 **L-9**

SYNCHRONOUS MOTOR : Principle of operation, Phasor diagram, V and inverted V-curves at constant power output, Hunting and damping, Starting methods, Phasor diagrams of salient pole motor.

MATHEMATICAL ANALYSIS: Expression for power developed, Conditions of maxima, Stiffness of coupling.

GRAPHICAL ANALYSIS: Excitation circles, Power circles, Maximum and minimum conditions.

UNIT - 5 **L-8**

SINGLE PHASE INDUCTION MOTOR: Constructional details, Double field revolving theory, Starting methods, Equivalent circuit, Determination of parameters, Performance curves and applications.

SPECIAL MOTORS : A.C. Series motor - Characteristics, Phasor diagram; Repulsion motor, Reluctance motor, Hysteresis motor, Universal motors, Permanent magnet motors, Stepper motors, Applications.

ACTIVITIES:

- *Design of simple armature and measure emf induced.*
- *Study of time to time voltage behavior of alternator.*
- *Determine the suitable voltage regulation method for alternator.*
- *Study the parallel operation of alternators in power generating plants (virtual lab).*
- *Trouble shoot a single phase induction motor.*

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS Total hours: 30

1. Regulation of a three phase alternator by synchronous impedance method.
2. Regulation of a three phase alternator by M.M.F. method.
3. Regulation of three phase alternator by Z.P.F. method.
4. Regulation of three phase alternator by A.S.A method.
5 V and Inverted V curves of a three phase synchronous motor.
6. Equivalent Circuit of a single phase induction motor.
7. Determination of Xd and Xq of a salient pole synchronous machine.
8. Parallel operation of alternator with infinite bus bar.
9. Determination of performance characteristics of single phase induction motor.
10. Load Test on three phase alternator

TEXT BOOKS:

1. P.S. Bimbhra, “Electrical Machinery”, 7th edition, Khanna publishers, 2007.
2. I.J. Nagrath and D.P. Kothari, “Electrical Machines”, 3rd edition, Tata Mc-Graw Hill, 2006.

REFERENCE BOOKS:

1. Alexander S.Langsdorf, “Theory of alternating current machinery”, 2nd edition, Tata Mc-Graw Hill, 2005.
2. M.G. Say, “Performance and design of alternating current machines”, 3rd edition, CBS, 2002.
3. Charles I Hubert, “Electric Machines (Theory, operation, applications, adjustment and control)”, 2nd edition, Pearson India, 2009.