Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

SCHEME OF EXAMINATION
DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

M.Tech. in Electrical Devices & Power System Engineering
FIRST SEMESTER

S. NO.	Board of Study	Subject Code	Subject	Period per Week			Scheme of exam			Total Marks	Credit L+(T+P)/2
							Theory/Practical				
				L	T	P	ESE	CT	TA		
1	Electrical and Electronics Engg.	570111(25)	High Voltage Engineering	3	1	-	100	20	20	140	4
2	Electrical Engg.	559113(24)	Power System Protection	3	1	-	100	20	20	140	4
3	Electrical Engg.	559114(24)	Flexible AC Transmission System (FACTS)	3	1	-	100	20	20	140	4
4	Electrical and Electronics Engg.	570112(25)	Industrial Drive and Control	3	1	-	100	20	20	140	4
5	Refer Table-I		Elective-I	3	1	-	100	20	20	140	4
6	Electrical Engg.	570121(24)	Power System Protection Lab.	-	-	3	75	-	75	150	2
7	Electrical and Electronics Engg.	570122(25)	High Voltage Lab.	-	-	3	75	-	75	150	2
Total				**15**	**5**	**6**	**650**	**100**	**250**	**1000**	**24**

Table 1

Elective- I			
S. No.	**Board of Study**	**Subject Code**	**Subject**
1	Electrical and Electronics Engg.	570131 (25)	Energy System
2	Electrical Engg.	559111(24)	Power System Dynamics
3	Electrical and Electronics Engg.	570132 (25)	Advanced Engineering Mathematics

Lecture T- Tutorial P- Practical ESE- End Semester Exam

CT- Class Test TA- Teachers Assessment

Note (1) – 1/4th of total strength of students subject to minimum of eighteen students is required to offer an
elective in the college in a Particular academic session .
Note (2) – Choice of elective course once made for an examination cannot be changed in **future**

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.TECH. 1st**
Subject: **High Voltage Engg.**
Total Theory Periods: **40**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: **02**

Specialization: Electrical Devices and Power System Engg.
Branch: **Electrical and Electronics Engineering**
Code: **570111(25)**
Total Tutorial Periods: **12**

UNIT-I

Generation of High Voltages:

Direct Voltage: AC to DC converter, Electrostatic Generators; Alternating **Voltage:** Testing Transformer, Series Resonant Circuit; **Impulse Voltage:** Impulse voltage generator circuits, Design, construction and operation of generator and control system.

UNIT-II

Measurement of High Voltages: Introduction to Sphere gap, Rod gap and uniform field gap; The Chubb-Fortes cue method, Voltage divider and passive rectifier circuits, Active peak reading circuit, High voltage capacitor measuring circuits, Voltage divider system and measurement of impulse voltage, Fast digital transient recorder for impulse voltage measurement

UNIT-III

Electrostatic field and field stress control: Electrical field distribution and breakdown strength of insulating materials, Fields in homogeneous and multi dielectric isotopic materials, Numerical methods.

UNIT-IV

Breakdown in Gases: Classical gas laws, Ionization and decay process, Cathode process- secondary effects, The Townsend mechanism, Streamer mechanism of spark, Paschen's law, penning effect, Breakdown field strength, Breakdown in non-uniform field, Effect of electron attachment on breakdown criteria, Influence of space charge-Polarity effect, Surge breakdown voltage-time lag and Corona.

UNIT-V

Breakdown in Solid & Liquid dielectrics: Intrinsic, Streamer, electromechanical, thermal and erosion breakdown of solid dielectrics; Treeing and Tracking in solid insulating materials, Electronic and suspended solid particle breakdown mechanism, cavity breakdown, Electro convection and electro hydrodynamic model of dielectrics, Static electrification in Power Transformer.

Text Books:

1. Conduction and Breakdown in Mineral Oils By A.A. Zaky and R. Hawley**..** Pergamon Press, Oxford, 1973.
2. Simple Dielectric Liquids by T.J. Gallagher. Clarendon Press, Oxford, 1975.
3. Dielectric Relaxation in Solids. By A.K. Jonscher,**.** Chelsea Dielectrics Press, London, 1983.
4. Electronic Processes in Non-crystalline Materials. N.F Mott and E.A. Davies Oxford University Press 1979.
5. High Voltage Measurement Techniques A.J. Schwab. M.I.T Press, 1972.

Reference books:

6. Technology of Electrical Measurements. See Chapter 4 in L. Schnell (ed.).. John Wiley and Sons Ltd, 1993,
7. Alternating-Current Bridge Methods (5th ed). By B. Hague Pitman & Sons, London, 1962.

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.TECH. 1st**
Subject: **Power System Protection**
Total Theory Periods: **40**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted:

Specialization: Electrical Devices and Power System Engg.
Branch: **Electrical and Electronics Engineering**
Code: **559113 (24)**
Total Tutorial Periods: **12**

Unit 1

Protective Relaying - Qualities of relaying, Definitions, Codes, Standards, Characteristic Functions, Classification, analog-digital - numerical, schemes and design, factors affecting performance, zones and degree of protection, faults types and evaluation, Instrument transformers for protection.

Unit 2

Basic static relay units, sequence networks, fault sensing data processing units, FFT and Wavelet based algorithms, Phase& Amplitude Comparators, Duality, Zero Crossing/Level Defectors,
Relay Schematics and Analysis, Over Current Relay, Instantaneous/Inverse Time –IDMT Characteristics; Directional Relays; Differential Relays, Restraining Characteristics; Distance Relays: Types, Characteristics;

Unit 3

Protection of Power System Equipment, Generator, Transformer, Generator, Transformer Units, Transmission Systems, Bus-bars, Motors; Pilot wire and Carrier Current Schemes;
System grounding, ground faults and protection, Load shedding and frequency relaying, Out of step relaying, Re-closing and synchronizing.

Unit 4

Numerical relays, Characteristics, Functional Diagrams, architecture, algorithms, Microprocessor & DSP based relays, sampling, aliasing, filter principles,
Integrated and multifunction protection schemes, SCADA based protection systems, FTA, Testing of Relays.

Unit 5

AC Circuit Breakers : Current interruption, Transient Recovery Voltage (TRV) , Rate of rise of TRV, Resistance switching, Damping of TRV, Opening Resistors, Inductive & Capacitive current interruptions , Current chopping , Rated characteristics of Circuit breakers, Types of Circuit Breakers, Testing of High Voltage AC Circuit Breakers

Text Books:-

1 C.R. Mason, The art and science of protective relaying, John Wiley & Sons.
2 A.R.Warrington, Protective Relays, Vol .1&2, Chapman and Hall.

REFERENCES:

1. T.S.Madhav Rao, Power system protection static relays with microprocessor applications, Tata McGraw Hill Publication.
2. Power System Protection Vol. I, II , III&IV, The Institution Of Electrical Engineers, Electricity Association Services Ltd., 1995
3. Helmut Ungrad , Wilibald Winkler, Andrzej Wiszniewski, Protection techniques in electrical energy systems, Marcel Dekker, Inc.
4. Badri Ram , D.N. Vishwakarma, Power system protection and switch gear, Tata McGraw Hill.
5. Blackburn, J. Lewis ,Protective Relaying, Principles and Applications, Marcel Dekker, Inc., 1986.
6. Anderson, P.M, Power System Protection,. McGraw-Hill, 1999
7. Singh L.P ,Digital Protection, Protective Relaying from Electromechanical to Microprocessor, John Wiley
   & Sons, 1994
8. Wright, A. and Christopoulos, C, Electrical Power System Protection,. Chapman & Hall, 1993,

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.Tech. 1st**
Subject**: Flexible AC transmission System (FACTS)**
Total Theory Periods: **40**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: **02**

Specialization: Electrical Devices and Power System Engg..
Branch: **Electrical Engineering**
Code: **559114 (24)**
Total Tutorial Periods: **12**

Unit I
FACTS Concept and General System Considerations, Power Flow in AC System, Definitions on FACTS, Basic Types of FACTS Controllers.
Converters for Static Compensation, Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM), GTO Inverters, Multi-Pulse Converters and Interface Magnetics,

Unit II
Transformer Connections for 12 , 24 and 48 pulse operation, Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM), Multi-level inverters of Cascade Type and their modulation, Current Control of Inverters

Unit III
Static Shunt Compensators, SVC and STATCOM, Operation and Control of TSC, TCR, STATCOM, Compensator Control, Comparison between SVC and STATCOM, STATCOM for transient and dynamic stability enhancement

Unit IV
Static Series Compensation, GCSC, TSSC, TCSC and SSSC, Operation and Control, External System Control for Series Compensators, SSR and its damping, Static Voltage and Phase Angle Regulators, TCVR and TCPAR, Operation and Control

Unit V
UPFC and IPFC, The Unified Power Flow Controller, Operation, Comparison with other FACTS devices, control of P and Q, Dynamic Performance, Special Purpose FACTS Controllers, Interline Power Flow Controller, Operation and Control**.**

Text Books:
1. N.G. Hingorani & L. Gyugyi: Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems. IEEE Press, 2000.
2. T.J.E Miller, Reactive Power Control in Electric Systems John Wiley & Sons

REFERENCES:
1. Ned Mohan et.al: Power Electronics.John Wiley and Sons.
2. 'FACTS Controllers and applications" course book for STTP, 2003, Dr Ashok S & K S Suresh kumar

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.TECH. 1st**
Subject: **Industrial Drives and Control**
Total Theory Periods: **40**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: **02**

Specialization: Electrical Devices and Power System Engg.
Branch: **Electrical and Electronics Engineering**
Code: **570112 (25)**
Total Tutorial Periods: **12**

UNIT I

Introduction: Review of solid state devices, switch characteristics and their comparison, semi-conductor materials.

UNIT II

Industrial Electronic Devices Phase controllers, Dual converters, Choppers, Cyclo-converters, Inverters, Power Supplies, Multivibrators, Switching Transistors and Timers.

UNIT III

Design of Industrial Electronic Devices Design and analysis of electromagnetic control of electric drives, their characteristics, operating modes, Motor Control, Heating and Welding Control, Opto-electronics and Optical Fibers, Servomotors and their applications. Resonant converters; Modeling strategies. Analysis and design of Power Electronics Circuit.

UNIT IV

Industrial application of Industrial Electronic Devices Control of electric drives used in manufacturing and process industries, protection of electric drives using solid state devices and controllers, analysis of drive systems. Stepper motor and Drive configurations. Brush less DC drive configuration. Low speed commutation. Inverter control strategies.

UNIT V

Testing for drive controllers Design and testing of microprocessor based drive controllers, analysis of solid state control of industrial drives, design and testing of thyristor based controllers for electric drives

***TEXT BOOKS*:**

1. Dubey G.K., Power Semiconductor Controlled Drive, Prentice Hall, New Jersey
2. Sen P.C., Thyristor Controlled DC Drives, Wiley, New York
3. Murphy J.M.D. and Turnbull F.G., Power Electronics Control of AC Motors, Franklin Book Co.

***REFERENCE BOOKS*:**

4. Bose B.K., Power Electronics and AC Drives, Prentice Hall, New Jersey
5. Bose B.K., Power Electronics and Variable Frequency Drives-Technology and applications, IEEE Pres

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.TECH. 1st**
Subject: ***Energy System***
Total Theory Periods: **40**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: **02**

Specialization: Electrical Devices and Power System Engg.
Branch: **Electrical and Electronics Engineering**
Code: **570131 (25)**
Total Tutorial Periods: **12**

UNIT-I

Energy and Environment

Fundamental Concepts of Energy: Laws of thermodynamics as applied to energy transfer and transformations: Heat transfer and insulation.

UNIT-II

Energy Sources: Conventional - Fossil fuel, hydro-power and nuclear power, non conventional - solar, wind, hydel, geothermal, tidal, biomass.

UNIT-III

Energy Convention Systems: Environmental aspects of energy conversion systems, thermal power plants- fuel processing, process of combustion, thermal and air pollution aspects, problems of fly-ash, hydro-electric power plants (including mini and micro power plants) – location, impacts on land, water and ecological resources, nuclear power plants – environmental consequences of nuclear fuel handling, power generation and waste disposal.

UNIT-IV

Energy Audit: Types and recommended practices

Energy Management - Problems & Prospects: Energy management strategies both at generation and demand ends, alternate sources of energy; need for appropriate technologies, energy demand patterns and strategies for energy conversation, energy management in industrial sector and its effect on environment.

UNIT-V

Non-conventional energy resources; Solar, geothermal, wind, hydrogen, nuclear energy.

***TEXT BOOKS*:**

1. Rau JG and Wooten DC, "Environmental Impact Assessment", McGraw Hill, New Delhi
2. R.E. Munn, "Environmental Impact Assessment", John Wiley and Sons, New York, USA

***REFERENCE BOOKS*:**

1. J.M. Smith, H.C., Van Ness, "Introduction to Chemical Engineering Thermodynamics", McGraw Hill, New York, USA

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.Tech. 1st** Specialization: Electrical Devices and Power System Engg..
Subject: **Power System Dynamics** Branch: **Electrical Engineering**
Total Theory Periods: **40** Code: **559111 (24)**
Total Marks in End Semester Exam. : **100** Total Tutorial Periods: **12**
Minimum number of class test to be conducted: **02**

UNIT-1

Elementary Mathematical Model: Swing Equation , Units , Mechanical Torque , Electrical Torque , Power - Angle Curve of a Synchronous Machine , Natural Frequencies of Oscillation of a Synchronous Machine , System of One Machine against an Infinite Bus- The Classical Model , Equal Area Criterion , Classical Model of a Multimachine System, Classical Sta bility Study of a Nine-Bus System, Shortcomings of the Classical Model, Block Diagram of One Machine.

UNIT-2

Synchronous Machine: Park's Transformation , Flux Linkage Equations , Voltage Equations , Formulation of State - Space Equations , Current Formula tion , Per Unit Conversion , Normalizing the Voltage Equations, Normalizing the Torque Equations , Torque and Power , Equivalent Circuit of a Synchronous Machine , The Flux Linkage State -Space Model , Loaf Equations , Sub transient and Transient Inductances and Time Constants , Turbine Generator Dynamic Models

UNIT-3

Simulation of Synchronous Machine: Steady-State Equations and Phasor Diagrams, Machine Connected to an Infinite Bus through a Transmission Line, Machine Connected to an Infinite Bus with Local Load at Machine Terminal, Determining Steady- State Conditions, Initial Conditions for a Multimachine System , Determination of Machine Parameters from Manufacturers' Data , Analog Computer Simulation of the Synchronous Machine, Digital Simulation of Syn chronous Machines.

Linear Model of Synchronous Machine: Linearization of the Generator State -Space Current Model,

Linearization of the Load Equation for the One-Machine Problem, Linearization of the Flux Linkage Model, Simplified Linear Model, Block Diagrams, State-Space Representation of Simplified Model.

UNIT-4

Excitation Systems: Simplified View of Excitation Control, Control Configurations, Typical Excitation Configurations, Excitation Control System Definitions, Voltage Regulator, Exciter Buildup, Excitation System response, State – Space Description of the Excitation System, State Space Representation of the Excitation system, Computer Representation of Excitation Systems, Typical Systems Constants, The effect of Excitation on Generator Performance.

Effect of Excitation on Stability: Effect of Excitation on Generator Power limits, Effect of the Excitation System on Transient Stability, Effect of Excitation on Dynamic Stability, Root – Locus Analysis of a Regulated Machine Connected to an Infinite Bus , Approximate System Representation, Supplementary Stabilizing Signals, Liner Analysis of the Stabilized Generator. General Comments on the Effect of Excitation on Stability.

UNIT-5

Multimachine Systems with Constant Impedance Load: Statement of the Problem, Matrix representation

of a Passive Network, Converting Machine Coordinates to System Reference, Relation Between Machine Currents & Voltages, System Order, Machines Represented by Classical Methods, Linearized Model for the Network, Hybrid Formulation, Network Equation with Flux Linkage Model, Total System Equation, Multimachine System Study.

Text Books:

1. Power System Control and Stability Vol -I By P. M. Anderson & A. A. Fouad.
2. Power System Stability and Control by Prabha Kundur - EPRI. Mc Graw Hill Inc.

Reference Books:

1. Power System Dynamic Stability and Control, Padiyar Interline Publisher Bangalore

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.TECH. 1st**
Subject: Advanced Engineering Mathematics
Total Theory Periods: **40**
Total Marks in End Semester Exam. : **100**
Minimum number of class test to be conducted: **02**

Specialization: Electrical Devices and Power System Engg..
Branch: **Electrical and Electronics Engineering**
Code: **570132 (25)**
Total Tutorial Periods: **12**

UNIT - I CALCULUS OF VARIATION

Functional – Euler's equation – Variational problems involving one unknown function Several unknown functions – Functionals dependent on higher order derivatives – Several independent variables – Isoperimetric problems.

UNIT - II Z – TRANSFORM

Transform of standard functions – Convolution – Initial and Final value problems –Shifting Theorem – Inverse transform (Using Partial Fraction – Residues) – Solution of difference Equations using Z – Transform.

UNIT - III SINGLE OBJECTIVE OPTIMIZATION ALGORITHM

Optimal problem formulation: Constraints, objective functions, variable bounds. Single variable optimization algorithm: optimality criteria – bracketing method; exhaustive search method & bounding phase method. Region elimination methods – interval halving method, Fibonnaci search method – Root finding using optimization technique.

UNIT – IV MULTI OBJECTIVE OPTIMIZATION PROBLEMS

Basic concepts – non-dominated solutions – preference structures, basic solution approach – Weighted sum approach; Random weight approach, Adaptive weight approach. Distance method, concepts – calculation of distance measure – applications. Compromise approach and goal programming approach.

UNIT - V CONSTRAINED OPTIMIZATION ALGORITHM

Khun – Tucker conditions – transformation methods; penalty function method and multiplier method – sensitivity analysis – direct search for constrained minimization; variable elimination method, complex search method, random search method – Generalized reduced gradient method – gradient projection method.

***TEXT BOOKS*:**

1. S. S. Rao, "Optimization – Theory and Applications", Wiley Eastern Limited, Second Edition, 1984.

***REFERENCE BOOKS*:**

2. Kalyanmoy Deb, "Optimization for Engineering Design – Algorithms and Examples", Prentice Hall India, Fifth printing, 2002

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.Tech. 1st**
Subject**: Power System Protection**
Total Practical Periods: **40**
Total Marks in End Semester Exam. : **75**

Specialization : Electrical Devices and Power System Engg..
Branch: **Electrical Engineering**
Code: **559121 (24)**

List of Experiments:

- Ratio Test of a C.T and determination of error.
- Determination of knee point voltage of a CT.
- 3 Summation Transformer characteristics.
- Study of CT Connection for E/F protection.
- Study of Open delta PT Connection for earth fault indication.
- Protection of 3 ph. Alternater (simulation study).
- Protection of 3 ph. Induction Motor (simulation study).
- Over current / under voltage / Negative seq Relay Characteristics (simulation study).
- Simulation of Transmission line protection.
- Study of differential protection of transformer (simulation study).

Chhattisgarh Swami Vivekanand Technical University Bhilai (C.G.)

Semester: **M.TECH. 1st**
Subject: High Voltage Lab
Total Theory Periods: **40**
Total Marks in End Semester Exam. : **75**

Specialization: Electrical Devices and Power System Engg..
Branch: **Electrical and Electronics Engineering**
Code: **570122 (25)**

List of Experiments:

1. High voltage AC measurement.
2. High voltage DC measurement.
3. High Impulse voltage measurement.
4. Study of break down phenomena in air, oil and solid dielectrics under uniform and non-uniform electrode configurations.
5. Capacitance and loss tangent measurement.
6. Partial discharge measurement.
7. Measurement of Earth resistance.
8. Measurement of resonant frequencies and internal voltage distribution in transformer windings.
9. Electromagnetic field measurement using field meter.
10. Measurement of harmonics using Energy analyzer.