Scheme for B.Tech. Engineering with Honors

Department of Electrical Engineering

B. Tech. with Honours (List of Courses)

S. No.	Course Title	Semester	Credits (L T P)
1.	Modelling & Simulation of Power Electronic Systems	V	3 (3 0 0)
2.	Special Electrical Machines and Applications	V	3 (3 0 0)
3.	Advanced Power System Protection	VI	3 (3 0 0)
4.	Nonlinear Control Systems	VI	3 (3 0 0)
5.	Power System Dynamics	VII	3 (3 0 0)
6.	Switched Mode Power Conversion	VIII	3 (3 0 0)
		Total Credits	**18**

SYLLABUS -B.TECH. WITH HONOURS (ELECTRICAL ENGINEERING)

Semester: V

Course Title: Modelling & Simulation of Power Electronics System

Course Type: Honours **Credit: 3 (3 0 0)**

Computer Simulations: Challenges in computer simulations, simulation process, types of analysis, model, model types, use of models, mechanics of simulation, circuit-oriented simulators (PSPICE/LTSPICE/PSIM), equation solvers, comparison of circuit-oriented simulators and equation solvers, discretization of time, transient analysis, numerical methods for solving ordinary differential equations, stability of numerical methods, application of numerical methods to solve primitive electric circuits, implementation of numerical methods in MATLAB script files.

Simulation of Power Electronic Converters: Concepts of volt-sec and amp-sec balance, understanding of switched-networks, KCL and KVL violations in switched-network, power loss of practical switching devices and simulation verification, understanding of BUCK, BOOST, and BUCK-BOOST converter startup, transient and steady-state through circuit simulations, development and simulation of differential equation-based simulation models of BUCK, BOOST, and BUCK-BOOST converter.

Case Studies: P-cell and N-cell unification of BUCK, BOOST, and BUCK-BOOST converter, switched and average model simulation of BUCK, BOOST, and BUCK-BOOST converter, modeling of dc motor, design of current and speed controller for a dc motor, simulation of closed-loop control of dc motor, mathematical modeling of three-phase inverter and high-power factor boost AC to DC converter.

Text/ References Books:

1. N. Mohan, T.M. Udeland, and W.P. Robbins, "Power Electronics: Converters, Applications, and Design," J. Wiley and sons, New York, 1994.
2. P.C. Krause, "Analysis of electric machinery", McGraw Hill, New York, 1986.
3. M. Godoy Simoes, Felix A. Farret, "Modeling Power Electronics and Interfacing Energy Conversion Systems", Wiley-IEEE Press, 2016.
4. Seddik Bacha Iulian Munteanu Antoneta Iuliana Bratcu, "Power Electronic Converters Modeling and Control", Springer, 2014.
5. Weidong Xiao, "Power Electronics Step-by-Step Design, Modeling, Simulation, and Control", Mc Graw Hill, 2021.
6. M B patil, V. Ramanarayanan, V T Ranganathan, "Simulation of Power Electronic Circuits", Narosa, 2009.
7. Relevant IEEE Transactions and Journals.

Semester: V

Course Title: Special Electrical Machines and Applications

Course Category: Honours **Credit: 3 (3 0 0)**

Special Induction Machines: Dual winding Squirrel cage induction generator (SCIG), Soft starters, reactive power compensation for SCIG, Wound rotor induction generator (WRIG), Doubly fed induction generator (DFIG), Brushless doubly fed induction generator, application prospects of DFIG to wind energy conversion system, effect of time harmonics in supply voltage, space harmonics in field flux, single phasing, harmonic synchronous and induction torques, noise and its reduction.

Special Synchronous Machines: Wound rotor synchronous generators for renewable energy applications, Wound rotor synchronous generators and Permanent magnet synchronous generators in large and small direct drive wind turbines, Transient performance of synchronous machines. Analysis of three phase symmetrical short circuit. Various inductances and time constants of synchronous machines, models for transient analysis. Transient Power/Angle characteristics, Vector diagrams for steady and transient conditions.

Fractional Horse-Power and other Special Machines: Qualitative treatment of stepper, hysteresis Linear Induction motors, MEGLEVS, BLDC, PMSM, Servomotors, Synchros.

Application Specific Machines: Selection of motors for electric vehicle, drone, healthcare, transportation, and industrial applications.

Text/ References Books:

1. Bin Wu, Yongqiang Lang, Navid Zargari, Samir Kouro, Power Conversion and Control of Wind Energy Systems, Wiley-IEEE Press, 2011.
2. Paul C. Krause; Oleg Wasynczuk; Scott D. Sudhoff, Analysis of Electric Machinery and Drive Systems, Wiley-IEEE Press, 2002.
3. Seung-Ki Sul, Control of Electric Machine Drive Systems, Wiley-IEEE Press, 2011.
4. M.E. El-Hawary, Principles of Electric Machines with Power Electronic Applications, Wiley-IEEE Press, 2002.
5. E. Fitzgerald, Charles Kingsley and Stephen D Umans: Electric Machinery, McGraw Hill Publication.
6. S. Langsdorf: Theory of Alternating Current Machinery, Tata McGraw Hill.

Semester: VI

Course Title: Advanced Power System Protection

Course Category: Honours **Credit: 3 (3 0 0)**

Prerequisite: Knowledge of UG level course on Switchgear and Protection

Protective Current & Potential Transformers: Steady state performance, Accuracy, burden, standard class designation, Polarity marking and Transient performance of Current transformers. Potential transformer, Steady state and transient performance of capacitor voltage transformer.

Review of Electromagnetic Relays: relay terminology, basic protection schemes, overcurrent relays, distance relays, differential relays. Relay Coordination.

Static Relays: Basic elements, Functional circuits, Generalised theory of two input comparators, Amplitude and Phase comparators, Realization of different relays using comparators. Types of static comparators. Protection of transmission lines power transformers, alternators, induction motors. Bus zone protection.

Digital protection: Introduction and Fundamental of digital relays. Digital relaying algorithms.

Text Books/ References:

1. Power System Protection & Switchgear By B. Ram, McGraw Hill
2. Protective Relay, Their Theory & Practices Vol. 1 By A.R.C. Warrington, Chapman & Hall UK
3. Power System Protection- Static Relays By T.S.M. Rao Tata McGraw Hill
4. Fundamentals of Power System Protection By Y.G. Paithankar and S.R Bhide, Prentice-Hall of India, 2003.
5. Digital Protection- Protective Relaying from Electromechanical to Microprocessor By L. P. Singh, New Age International
6. Power System Protection By Patra Basu & Choudhary, Oxford & IBH
7. Power system Protection & Switchgear, Oza, Nair, Mehta, Makwana, Mc-Graw Hill

Semester: VI

Course Title: Nonlinear Control Systems

Course Category: Honours **Credit: 3 (2 1 0)**

Fundamental tools for nonlinear systems: Linear vs Nonlinear State Space Models; Nonlinear Phenomena; Physical Interpretation of Norm, Eigenvalues and Eigenvectors; Existence and uniqueness of solutions of dynamical systems; Continuous dependence on initial conditions and parameters; Comparison principles.

Nonlinear models and behaviour: Examples of nonlinear systems; Concept of equilibrium point; Qualitative behaviour of 2-dimensional systems; Phase plane analysis; Describing function approach.

Nonlinear system analysis: Idea of stability-Concept of internal and input-output stability for lineaer systems; Lyapunov stability of autonomous and nonautonomous systems; LaSalle's invariance principle; Converse Lyapunov theorems; Effects of Perturbations.

Systems with inputs and outputs: Input-to-state stability and related notions; Lyapunov characterizations; Stability of feedback systems.

Nonlinear Control Design: Control Lyapunov functions; Universal formulas for feedback stabilization and Backstepping; Feedback Linearization.

Text-books:

1. Hassan K. Khali: Nonlinear Systems, Prentice Hall, Third Edition 2002.
2. Jean-Jacques E. Slotine, and Weiping Li: Applied Nonlinear Control, Pearson Education-Prentice Hall, 2002.
3. H. K. Khalil: Nonlinear control, New York: Pearson, 2015.
4. Chi-Tsong Chen: Linear System Theory and Design, Oxford University Press, Fourth Edition 2013.
5. Isidori, A: Nonlinear control systems II. Springer London, 2013.

Reference(s):

1. William L. Brogan: Modern Control Theory, Pearson Education Third Edition 2011.
2. Sastry, Shankar: Nonlinear systems: analysis, stability, and control, Vol. 10. Springer Science & Business Media, 2013.

Semester: VII

Course Title: Power System Dynamics

Course Category: Honours **Credit: 3 (3 0 0)**

Dynamic models of synchronous machines, excitation system, loads.

Modelling of single machine-infinite bus system. Mathematical modelling of multi-machine system. Dynamic and transient stability analysis of single machine and multi-machine systems. Power system stabilizer design for multi-machine systems. Dynamic equivalencing. Voltage stability Techniques for the improvement of stability. Direct method of transient stability analysis: Transient energy function approach.

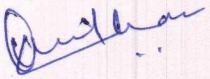
Effect of renewables on dynamics of power systems.

Text/ References Books:

1. Power System Stability and Control, P. Kundur Mc-Graw Hills

2. Computer Techniques in Power System Analysis, M A Pai, Mc-Graw Hill

3. Advanced Power System Analysis and Dynamics, L.P. Singh, Mc-Graw Hill



Semester: VIII

Course Title: Switched Mode Power Conversion

Course Category: Honours **Credit: 3 (3 0 0)**

Introduction: Overview of linear voltage regulators, shunt and series regulators, characteristics of Ideal and practical switch, introduction of switching circuits, harmonic concepts, power computations

Non-Isolated Switch-Mode DC-DC Regulators: Buck, Boost, Buck-Boost converters, Cuk converter, SEPIC converter, Zeta converter, small-signal modelling and analysis.

Isolated Switch-Mode DC-DC Converters: Transformer circuit configurations, half-bridge, full-bridge, flyback, forward, push-pull configurations.

Resonant Converters: Concept of soft-switching, classification and types of converters, ZCS and ZVS based buck and boost converter topologies.

Controller design: Concept of feedback control for output voltage regulation, voltage mode and current model control of switch mode dc-dc converters, PI and sliding mode controller design concepts.

Text/ References Books:

1. Rashid M. H., "Power Electronics Circuits Devices and Applications", 3rd Ed., Pearson Education.
2. Mohan N., Undeland T.M. and Robbins W.P., "Power Electronics-Converters, Applications and Design", 3rd Ed., Wiley India.
3. Whittington H.W., Aflynn B.W. and Macpherson D.E., "Switch Mode Power Supplies – Design and Construction", John Wiley and Songs.
4. Hart Daniel W., "Introduction to Power Electronics", Prentice Hall International Edition
5. Issa Batarseh, "Power Electronic Circuits", Wiley India