Curriculum of M.Sc. Electrical Engineering Technology Program

Curriculum

Sr. No.	Course Code	CORE COURSE	CREDIT HOURS
1	MSET-501	SCIENTIFIC WRITING & RESEARCH METHODOLOGY	3 (3-0)
2	MSET-502	OPTIMIZATION THEORY	3 (3-0)

Sr. No.	Course Code	ELECTIVE COURSES	CREDIT HOURS
1	MSET-503	POWER SYSTEM PLANNING	3 (3-0)
2	MSET-504	POWER SYSTEM OPERATION AND CONTROL	3 (3-0)
3	MSET-505	ADVANCED POWER SYSTEM PROTECTION	3 (3-0)
4	MSET-506	RENEWABLE ENERGY SYSTEMS	3 (3-0)
5	MSET-507	ADVANCED POWER SYSTEM ANALYSIS	3 (3-0)
6	MSET-508	SMART GRID SYSTEMS	3 (3-0)
7	MSET-509	ADVANCED LINEAR CONTROL SYSTEM	3 (3-0)
8	MSET-510	DIGITAL CONTROL SYSTEM	3 (3-0)
9	MSET-511	OPTICAL COMMUNICATION	3 (3-0)
10	MSET-512	WIRELESS & MOBILE COMMUNICATIONS	3 (3-0)
11	MSET-513	TELECOMMUNICATION NETWORKS MANAGEMENT	3(3-0)
12	MSET-514	ELETRONIC SYSTEM DESIGN	3 (3-0)

13	MSET-515	VLSI DESIGN	3 (3-0)
14	MSET-516	EMBEDDED SYSTEMS	3 (3-0)
15	MSET-517	ADVANCED ELECTROMAGNETIC THEORY	3 (3-0)
16	MSET-518	ADVANCED DIGITAL SIGNAL PROCESSING	3 (3-0)
17	MSET-519	MACHINE LEARNING	3 (3-0)
18	MSET-520	ARTIFICIAL INTELLIGENCE	3 (3-0)
19	MSET-521	ELECTRIC VECHILE TECHNOLOGIES	3 (3-0)

COURSE OUTLINES

SCIENTIFC WRITING & RESEARCH METHODOLOGY (MSET-501)

COURSE OUTLINE

Difference between Research & Non-Research, Objectives of Research, Grouping of Research, Motivation in Research, Basic Types of Research, Generating Theories – Models, identifying problems and solutions, Scientific Methods, 7 Special Features of Scientific Method, Research Process, Defining a research problem and selecting the Problem, Research Design, Features of a Good Design, Factors Affecting the Choice of Design, Elements of Research Design, Sampling Design, Stages in the Selection of a Sample, Characteristics of a Good Sample Design, Different Types of Sample Designs, Writing a Research Paper, The Process of Writing a Research Paper, Essential Parts of a Scientific paper, Plagiarism & Types of plagiarism, Adding Ethics to Engineering Education, ABET Code of Ethics, NSPE Code of Ethics, IEEE Code of Ethics, Nine Basic Steps to Personal Ethical Decision Making, Core Concepts in Engineering Ethics

RECOMMENDED TEXTS

Girden, Ellen R., and Robert Kabacoff, eds. *Evaluating research articles from start to finish*. Sage, 2010.

OPTMIZATION THEORY (MSET-502)

COURSE OUTLINE

Optimization theory & problems, unconstrained nonlinear problems, linear equality constrained problems , Linear inequality constrained problems, nonlinear equality constrained problems, nonlinear inequality constrained problems, methods; line search methods, trust-region methods, Newton's methods, linear and nonlinear conjugate gradient methods, simplex method, Penalty function methods, barrier function methods, augmented Lagrangian methods, Sequential linearly constrained methods, Convex optimization and related problems, Sequential quadratic programming methods

RECOMMENDED TEXTS

Fletcher, R., *Practical methods of optimization*. John Wiley & Sons, 2013.

POWER SYSTEM PLANNING (MSET-503)

COURSE OUTLINE

Power system planning, Stages in planning and design, Transition from planning to operation, Generating System capability Planning, Probabilistic models of generating units, Growth rate, Rate of generation capacity, Outage performance and system evaluation of loss of load and loss of energy indices, Power supply availability assessment. Interconnected Systems: Multi area reliability analysis, Power pool operation and power exchange energy contracts, Quantification of economic and reliability benefits of pool operation, Demand/ Energy forecasting: Electricity consumption pattern, Operation and maintenance costs of candidate units of different types, Peak demand and energy forecasting by trend and economic projection methods, Power System expansion planning: Formulation of least cost optimization problem involving capital, Design of Distribution Systems: Introduction, Optimal conductor selection, Capacitor placement, Reconfiguration, Substation planning, Case study of state of art industrial power plants.

RECOMMENDED TEXTS

Pabla, Amarjit Singh. *Electric power distribution*. Tata McGraw-Hill Education, 2012.

POWER SYSTEM OPERATION AND CONTROL (MSET-504)

COURSE OUTLINE

This course provides an in-depth understanding of the real-time operation and control of modern power systems. Topics include load forecasting, economic dispatch, unit commitment, automatic generation control (AGC), voltage and frequency control, and optimal power flow (OPF). The integration of renewable energy sources and their impact on system stability is covered. Practical case studies and MATLAB-based simulations help students analyze system behavior under different load conditions and control strategies.

RECOMMENDED TEXTS

- Wood, A. J., Wollenberg, B. F., & Sheblé, G. B. (2021). *Power Generation, Operation, and Control (4th Edition).* Wiley.
- Kundur, P. (2023). *Power System Stability and Control.* McGraw-Hill.
- Glover, J. D., Sarma, M. S., & Overbye, T. J. (2022). *Power System Analysis and Design (7th Edition).* Cengage Learning.

ADVANCED POWER SYSTEM PROTECTION (MSET-505)

COURSE OUTLINE

This course provides a comprehensive study of protective relaying techniques, fault detection, and mitigation strategies for modern power grids. It covers overcurrent, differential, distance, and adaptive protection schemes. Topics include digital relays, communication-based protection, cybersecurity in power systems, and the impact of renewable integration. Practical experiments using ETAP and MATLAB/SIMULINK enable students to simulate fault scenarios and develop protective strategies.

RECOMMENDED TEXTS

- Horowitz, S. H., & Phadke, A. G. (2023). *Power System Relaying (5th Edition).* Wiley.
- Blackburn, J. L., & Domin, T. J. (2021). *Protective Relaying: Principles and Applications (4th Edition).* CRC Press.
- Hewitson, M., Brown, M., & Ramesh, H. (2022). *Practical Power System Protection.*

Newnes.

RENEWABLE ENERGY SYSTEM (MSET-506)

COURSE OUTLINE

Energy Sources and Environmental Effects, Electrical Fundamentals, Solar Photovoltaics, Solar Power Systems – Electrical, Solar Power Systems, Thermal, Solar Tracking, Detailed design project using commercial design methods and tools, Charge Controllers, Inverters, Wind Power Fundamentals, Wind Power Systems, Wind Turbine Control, Biomass Technologies, Geothermal Power Generation, Hydropower, Fuel Cells, Second class project based on technology to be selected, Generators, Connecting to The Grid

RECOMMENDED TEXTS

Twidell, John. *Renewable energy resources*. Routledge, 2021.

ADVANCED POWER SYSTEM ANALYSIS (MSET-507)

COURSE OUTLINE

This course covers the Y-bus & Z-bus formation, modification, and reduction techniques Mutually coupled branches, equivalent admittance networks, Kron Reduction, Thevenin's theorem, and power-invariant transformations, Transient behavior in RL circuits, internal voltage under fault conditions, Fault calculations using Z-bus, selection of circuit breakers, Single-line-to-ground, line-to-line, and double-line-to-ground faults, Sequence components and networks for synchronous machines & transmission lines, Fault detection, protection schemes, and system reliability analysis.

RECOMMENDED TEXTS

Weedy, Birron Mathew, Brian John Cory, Nick Jenkins, Janaka B. Ekanayake, and Goran Strbac. *Electric power systems*. John Wiley & Sons, 2012.

SMART GRID SYSTEMS (MSET-508)

COURSE OUTLINE

This course provides an in-depth understanding of smart grid technologies, their transformational impact on the power industry, and how they enhance efficiency, reliability, and sustainability. It covers the fundamentals of smart grids, their architectures, integration of renewable energy, and advanced energy management techniques. Additionally, it explores communication technologies, demand-side management, microgrids, system reliability, cybersecurity, energy storage solutions, and ancillary services. The course also focuses on grid modernization trends, regulatory frameworks, and the role of artificial intelligence (AI) and blockchain in smart grid operations.

RECOMMENDED TEXTS

Keyhani, Ali. *Design of smart power grid renewable energy systems*. John Wiley & Sons, 2016.

ADVANCED LINEAR CONTROL SYSTEM (MSET-509)

COURSE OUTLINE

Introduction to State- Space, State- Space Representation, State- Space Representation-Controllable Canonical Form, Extended Controllable Canonical Form, Observable Canonical Form, Diagonal Canonical Form, Jordan Canonical Form, Numerical Examples on State-Space Modeling, Modeling of Mechanical System in State-Space, Modeling of DC Servo Motor, Determination of Transfer Function from State-Space Model, Concept of Eigen-Values and Eigen-Vectors, Lyapunov Stability Analysis (Sylvester's Criterion), Lyapunov Stability Analysis (Stability Criterion), Lyapunov Stability Analysis (Direct Method), Concept of Diagonalization, Solution of LTI State Equation, Solution of LTI State Equation (Forced System), Steady State Error for State Space System, Sate Transition Matrix, Controllability in State-Space, Observability in State-Space, Canonical Decomposition, Conditions in Jordan-Form Equations, Compensator Equations-Classical Method**,** State Feedback-Solving the Lyapunov Equation, Pole-Placement by State Feedback, Regulation and Tracking

RECOMMENDED TEXTS

Chi-Tsong Chen, *Linear System Theory and Design*, 4th Ed., Oxford University Press, 2014

DIGITAL CONTROL SYSTEM (MSET-510)

COURSE OUTLINE

Discrete Time System Representation Mathematical Modeling of Sampling Process, Data Reconstruction, Z-Transform, Mapping of s-plane to z-plane, Pulse Transfer Function of closed loop system, Sampled Signal Flow Graph, Jury Stability Test, Stability Analysis using Bi-Linear Transformation, Transient and Steady-State Responses of a prototype Second Order System, Introduction to State Variable Model, Various Canonical Forms, Characteristic Equation, State Transition Matrix, Solution to Discrete State Equation, Controllability and Observability, Stability, Lyapunov Stability Theorem, Pole Placement by State Feedback, Set Point Tracking Controller, Full Order Observer

RECOMMENDED TEXTS

B. C. Kuo, *Digital Control Systems*, 2nd Ed., Oxford University Press, 2007

OPTICAL COMMUNICATION (MSET-511)

COURSE OUTLINE

Scope of Photonics, Evolution of fiber optic systems, Operating range of 4 key components in the 3 different optical windows, Major elements of typical photonic communication link – Basic Communication & Digital Data Concepts, Concept of Wavelength Division Multiplexing, SONET & SDH Standards, Quantum nature of light, Wave guiding, Propagation Modes – Losses & Dispersion in Optical Fibers – Fiber Materials & Fabrication Procedures - Single Mode Fiber, Multimode and Specialty Fibers, Basic Concepts, Direct and Indirect Materials, Quantum Efficiency, Spectrum and power-current curves, Modulation Response – The 2 types of LEDs – Semiconductor LASERs, Important parameters, types and requirements – Common Photodetectors, Photodiodes characteristics and responsivity, 3 Sections of the Receiver – Noise

in Photodetectors, Quantum Limit, Power Penalty, Receiver performance, Launching optical power into a fiber, Coupling Efficiency, Lensing schemes – Fiber-to-Fiber coupling, Mechanical Misalignment Losses, Fiber Splicing and connectors, Connector Return Loss, Basic Concepts, Applications, Gain Saturation, Types of Optical Amplifiers, SOA, Various configurations of SOA, Raman Amplifier – EDFA Amplifier Noise, Two-Stage EDFA Design, Gain Flattening, Hybrid EDFA at 1.55um, EDFA Gain Transient, C-Band vs L-Band, Parallel Type EDFA, OSI & Layer Model, Types of Networks, The Optical Layer, Optical Cross Connects, Passive Optical Network (PON) Topologies, Elements of a Network, Add-Drop Bus-Coupler Losses – Synchronous Optical Networks, SONET Add Drop Multiplexers, SONET/SDH Rings, Generic SONET network, WDM Networks

RECOMMENDED TEXTS

Agrawal, Govind P. *Fiber-optic communication systems*. Vol. 222. John Wiley & Sons, 2012.

WIRELESS & MOBILE COMMUNICATIONS (MSET-512)

COURSE OUTLINE

The topics to be covered include: channel characterization and modelling (i.e., basic properties of multipath wireless channels and their modelling), communication concepts and techniques (i.e., point-to-point communication techniques that increase reliability, by exploiting time, frequency and spatial diversity), application of these concepts in a system context (i.e., cellular system design via a case study of three systems GSM, CDMA and OFDMA with special focus on multiple access and interference management issues) and key auxiliary concept of estimation and detection in an AWGN channel

RECOMMENDED TEXTS

Tse, David, and Pramod Viswanath. *Fundamentals of wireless communication*. Cambridge university press, 2005.

TELECOMMUNICATION NETWORKS MANAGEMENT (MSET-513)

COURSE OUTLINE

Basics of network management, alternative architectures, evaluation techniques, Fault and configuration Management, APIs in telecom, Network management system components, Introduction to FCAPS, TMN (Telecom Management Network) model and Logical Layer Architecture, Network Management Protocols: SNMP and CMIP management protocols, ISO network management applications: fault management, performance management, configuration management, security management, and accounting management, Practical experience of developing network and distributed systems management tools using the SNMP++ and Advent Net wrappers

RECOMMENDED TEXTS

Eugenio Iannone, *Telecommunication Networks,* CRC Press, 2017

ELECTRONIC SYSTEM DESIGN (MSET-514)

COURSE OUTLINE

Bipolar Junction Transistors, Basic BJT concepts and circuit models, BJT Amplifiers (bias circuits, small-signal and large-signal equivalent circuits), BJT Common Emitter and Common Collector amplifiers, Cascaded BJT amplifiers, Op-amp characteristics, closed loop and open loop gains, Schmitt trigger, steady state sinusoidal analysis, complex numbers, phasors, impedances, complex power, op-amp Filters: transfer functions, Bode Plots, first order active filters (low-pass and high pass), Digital Electronics, Different logic families, TTL, Emitter Coupled Logic, NMOS, PMOS, CMOS, Analog to Digital Converters (ADC), Digital to Analog Converters (DAC), 555 Timer, Instrumentation Amplifiers

RECOMMENDED TEXTS

Sedra, Adel S., Kenneth Carless Smith, Tony Chan Carusone, and Vincent Gaudet. *Microelectronic circuits*. Vol. 4. New York: Oxford university press, 2004.

VLSI DESIGN (MSET-515)

COURSE OUTLINE

Introduction to VLSI Systems, CMOS logic, fabrication and layout, MOS Transistor theory, Layout Design Rules, static and dynamic logic structures, interconnect analysis, CMOS chip layout, Circuit characterization and performance estimation, Circuit Simulation, Combinational and sequential circuit design, Memory system design, Design methodology and tools, VLSI architecture.

RECOMMENDED TEXTS

Weste, Neil HE, and David Harris. *CMOS VLSI design: a circuits and systems perspective*. Pearson Education, 2015.

Embedded Systems (MSET516)

COURSE OUTLINE

Introduction to Embedded Systems, Microcontrollers and Processors, Embedded C/C++ Programming, Input and Output Interfacing, Communication Protocols (UART, SPI, I2C, CAN), Timers and Interrupts, Real-Time Operating Systems (RTOS), Power Management in Embedded Systems, Debugging and Testing, Embedded System Applications (IoT, Automation, Robotics), Hands-on Projects with Microcontrollers and Development Kits.

RECOMMENDED TEXTS

- *Embedded Systems: Introduction to ARM Cortex-M Microcontrollers* – Jonathan W. Valvano
- *Embedded Systems Design: A Unified Hardware/Software Introduction* – Frank Vahid, Tony Givargis

Advanced Electromagnetic Theory (MSET-517)

COURSE OUTLINE

Maxwell's Equations and Their Applications, Electrostatics and Magnetostatics, Boundary Conditions and Material Interactions, Electromagnetic Wave Propagation, Transmission Lines and Waveguides, Antennas and Radiation Theory, Electromagnetic Interference and Compatibility, Microwave Engineering and Applications, Numerical Methods in Electromagnetics, Electromagnetic Applications in Modern Technology.

RECOMMENDED TEXTS

- *Classical Electrodynamics* – John David Jackson
- *Advanced Engineering Electromagnetics* – Constantine A. Balanis

Advanced Digital Signal Processing (MSET-518)

COURSE OUTLINE

Discrete-Time Signals and Systems, Z-Transform and Fourier Analysis, Digital Filter Design (FIR and IIR), Multirate Signal Processing, Adaptive Signal Processing, Wavelet Transform and Applications, DSP Algorithms and Architectures, Spectral Estimation Techniques, Statistical Signal Processing, Real-Time Signal Processing and Implementation.

RECOMMENDED TEXTS

- *Discrete-Time Signal Processing* – Alan V. Oppenheim, Ronald W. Schafer
- *Digital Signal Processing: Principles, Algorithms, and Applications* – John G. Proakis, Dimitris G. Manolakis

MACHINE LEARNING (MSET-519)

COURSE OUTLINE

Introduction to Machine Learning: Supervised, Unsupervised, and Reinforcement Learning, Applications of Machine Learning in various industries, Overview of ML tools and frameworks (Scikit-learn, TensorFlow, PyTorch), Data Preprocessing & Feature Engineering: Data collection and cleaning, Feature selection and extraction, Dimensionality reduction, Supervised Learning – Regression: Linear Regression and Polynomial Regression, Regularization techniques (Ridge, Lasso), Evaluation Metrics: RMSE, MAE, R^2 Score, Supervised Learning – Classification: Logistic Regression, Decision Trees & Random Forest, Support Vector Machines (SVM), Evaluation Metrics, Model Selection & Optimization: Cross-Validation Techniques, Hyperparameter Tuning (Grid Search, Random Search, Bayesian Optimization), Ensemble Learning & Boosting: Bagging & Random Forest, Boosting (AdaBoost, Gradient Boosting, XGBoost, LightGBM), Unsupervised Learning – Clustering: K-Means Clustering, Hierarchical Clustering, DBSCAN & Mean Shift, Unsupervised Learning – Dimensionality Reduction: Principal Component Analysis (PCA), Neural Networks & Deep Learning: Introduction to Neural Networks, Activation Functions & Backpropagation, Deep Learning Architectures

(CNN, RNN, Transformers)

RECOMMENDED TEXTS

1. "Pattern Recognition and Machine Learning" by Christopher M. Bishop
2. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron
3. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron

ARTIFICIAL INTELLIGENCE (MSET-520)

COURSE OUTLINE

Definition and History of AI, AI vs. Machine Learning vs. Deep Learning, Applications of AI in different domains, Ethical considerations in AI, State Space Search, Uninformed Search Algorithms (BFS, DFS, Uniform Cost Search), Informed Search Algorithms (A*, Greedy Best-First Search), Constraint Satisfaction Problems (CSPs), Introduction to Machine Learning, Types of Learning: Supervised, Unsupervised, Reinforcement , Basic concepts: Features, Labels, Training, Testing, Overfitting and Underfitting, Supervised Learning: Linear Regression, Polynomial Regression, Evaluation Metrics, Unsupervised Learning: Clustering, Regression, Dimensionality Reduction, Introduction to Neural Networks, Perceptron and Multi-Layer Perceptron (MLP), Activation Functions & Backpropagation, Introduction to Deep Learning Frameworks (TensorFlow, PyTorch, Keras), Computer Vision: Image Processing Basics, Convolutional Neural Networks (CNNs)

RECOMMENDED TEXTS

1. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig
2. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville
3. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

Electric Vehicle Technologies (MSET-521)

COURSE OUTLINE

Introduction to Electric Vehicles, EV Powertrain and Components, Battery Technologies and Energy Storage, Electric Motors and Control Systems, Power Electronics in EVs, Charging Infrastructure and Grid Integration, Vehicle Dynamics and Performance Analysis, Regenerative Braking Systems, Thermal

Management in EVs, Autonomous and Connected EV Technologies, Environmental and Economic Impact of EVs.
RECOMMENDED TEXTS
□ *Electric Vehicle Technology Explained* – James Larminie, John Lowry □ *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles* – Mehrdad Ehsani, Yimin Gao, Ali Emadi