

Syllabus of
UNDERGRADUATE DEGREE COURSE

B.Tech. VI Semester

Electrical Engineering



Rajasthan Technical University, Kota

Effective from session: 2022 – 2023



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE3-01: COMPUTER ARCHITECTURE

Credit: 2

Max. Marks: 100(IA:30, ETE:70)

2L+0T+0P

End Term Exam: 3 Hours

SN	CONTENTS	HOURS
1	Introduction: Objective, scope and outcome of the course.	01
2	Introduction to computer organization Architecture and function of general computer system, CISC Vs RISC, Data types, Integer Arithmetic - Multiplication, Division, Fixed and Floating point representation and arithmetic, Control unit operation, Hardware implementation of CPU with Micro instruction, microprogramming, System buses, Multi-bus organization.	05
3	Memory organization System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.	04
4	Input – output Organization Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port. Features of PCI and PCI Express bus.	05
5	16 and 32 microprocessors 80x86 Architecture, IA – 32 and IA – 64, Programming model, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, Addressing modes of 80x86, Instruction set of 80x86, I/O addressing in 80x86	05
6	Pipelining Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.	04
7	Different Architectures VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming.	04
	TOTAL	28



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE4-02: POWER SYSTEM –II

Credit: 3
3L+0T+0P

Max. Marks: 100(IA:30, ETE:70)
End Term Exam: 3 Hours

SN	CONTENTS	HOURS
1	Introduction: Objective, scope and outcome of the course.	01
2	Power Flow Analysis Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of nonlinear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.	08
3	Stability Constraints in synchronous grids Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three--phase fault. Analysis using numerical integration of swing equations (using methods like Forward Euler, Runge-Kutta 4th order methods), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability.	10
4	Control of Frequency and Voltage Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap Changing Transformers. Power flow control using embedded dc links, phase shifters	08
5	Monitoring and Control Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems. State-estimation. System Security Assessment. Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis. Preventive Control and Emergency Control	08
6	Power System Economics and Management Basic Pricing Principles: Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.	06
	TOTAL	41



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE4-03: POWER SYSTEM PROTECTION

Credit: 3
3L+0T+0P

Max. Marks: 100(IA:30, ETE:70)

End Term Exam: 3 Hours

SN	CONTENTS	HOURS
1	Introduction: Objective, scope and outcome of the course.	01
2	Introduction and Components of a Protection System Principles of Power System Protection, Relays, Instrument transformers, Circuit Breakers.	04
3	Faults and Over-Current Protection Review of Fault Analysis, Sequence Networks. Introduction to Overcurrent Protection and overcurrent relay co-ordination.	08
4	Equipment Protection Schemes Directional, Distance, Differential protection. Transformer and Generator protection. Bus bar Protection, Bus Bar arrangement schemes.	08
5	Digital Protection Computer-aided protection, Fourier analysis and estimation of Phasors from DFT. Sampling, aliasing issues.	07
6	Modeling and Simulation of Protection Schemes CT/PT modeling and standards, Simulation of transients using Electro-Magnetic Transients (EMT) programs. Relay Testing.	08
7	System Protection Effect of Power Swings on Distance Relaying. System Protection Schemes. Under-frequency, under-voltage and df/dt relays, Out-of-step protection, Synchro-phasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS). Application of WAMS for improving protection systems.	06
	TOTAL	42



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE4-04: ELECTRICAL ENERGY CONSERVATION And AUDITING

Credit: 3
3L+0T+0P

Max. Marks: 100(IA:30, ETE:70)
End Term Exam: 3 Hours

SN	CONTENTS	HOURS
1	Introduction: Objective, scope and outcome of the course.	01
2	Energy Scenario Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.	04
3	Basics of Energy and its Various Forms Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.	08
4	Energy Management & Audit Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.	08
5	Energy Efficiency in Electrical Systems Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.	07
6	Energy Efficiency in Industrial Systems Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.	08
7	Energy Efficient Technologies in Electrical Systems Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.	06
TOTAL		42

Office of Dean Academic Affairs
Rajasthan Technical University, Kota



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE4-05: ELECTRICAL DRIVES

Credit: 3
3L+0T+0P

Max. Marks: 100(IA:30, ETE:70)
End Term Exam: 3 Hours

SN	CONTENTS	HOURS
1	Introduction: Objective, scope and outcome of the course.	01
2	DC motor characteristics Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed, flux weakening for high speed operation	05
3	Chopper fed DC drive Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting..	05
4	Multi-quadrant DC drive Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking	06
5	Closed-loop control of DC Drive Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification and design, speed controller specification and design.	05
6	Induction motor characteristics Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation, vector control of IM, Direct torque control of IM.	06
7	Scalar control or constant V/f control of induction motor Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation.	06
8	Control of slip ring induction motor Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery.	06
	TOTAL	40



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE5-11: POWER SYSTEM PLANNING

Credit: 3
3L+0T+0P

Max. Marks: 100(IA:30, ETE:70)

End Term Exam: 3 Hours

SN	CONTENTS	HOURS
1	Introduction: Objective, scope and outcome of the course.	01
2	Introduction of power planning: National and Regional Planning, structure of Power System, planning tools. Electricity Regulation, Electrical Forecasting, forecasting techniques modeling.	08
3	Power system Reliability: System Reliability, Reliability Planning Criteria for Generation, Transmission and Distribution, Grid Reliability, Reliability Target, Security Requirement, Disaster Management, Roadmap for Reliability and Quality.	08
4	Generation Planning: Objectives & Factors affecting Generation Planning, Generation Sources, Integrated Resource Planning, Generation System Model, Loss of Load (Calculation and Approaches), Outage Rate, Capacity Expansion, Scheduled Outage, Loss of Energy, Evaluation Methods. Interconnected System, Factors affecting interconnection under Emergency Assistance.	08
5	Transmission & Distribution Planning: Introduction, Objectives of Transmission Planning, Network Reconfiguration, System and Load Point Indices, Data required for Composite System Reliability. Radial Networks – Introduction, Network Reconfiguration, Evaluation Techniques, Interruption Indices, Effects of Lateral Distribution Protection, Effects of Disconnects, Effects of Protection Failure, Effects of Transferring Loads, Distribution Reliability Indices.	08
6	Demand Side Planning: Computer aided planning, wheeling. Environmental effects, the greenhouse effect. Technological impacts. Insulation coordination. Reactive compensation.	08
	TOTAL	41



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE5-12: DIGITAL SIGNAL PROCESSING

Credit: 3
3L+0T+0P

Max. Marks: 100(IA:30, ETE:70)

End Term Exam: 3 Hours

SN	CONTENTS	HOURS
1	Introduction: Objective, scope and outcome of the course.	01
2	Discrete-time signals and systems Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.	06
3	Z-transform z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using ztransform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.	06
4	Discrete Fourier Transform Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.	10
5	Design of Digital filters Design of FIR Digital filters: Windowmethod, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Bandstop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.	11
6	Applications of Digital Signal Processing Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.	06
	TOTAL	40



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE5-13: ELECTRICAL AND HYBRID VEHICLES

Credit: 3
3L+0T+0P

Max. Marks: 100(IA:30, ETE:70)
End Term Exam: 3 Hours

SN	CONTENTS	HOURS
1	Introduction: Objective, scope and outcome of the course.	01
2	Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.	05
3	Hybrid Electric Vehicles History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	07
4	Electric Trains Electric Drive-trains: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	10
5	Energy Storage Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.	10
6	Energy Management Strategies Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	08
	TOTAL	41



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE4-21: POWER SYSTEM - II LAB

Credit: 2
OL+OT+4P

Max. Marks: 100(IA:60, ETE:40)
End Term Exam: 3 Hours

1. Fault analysis (for 3 to 6 bus) and verify the results using MATLAB or any available software for the cases: (i) LG Fault (ii) LLG Fault (iii) LL Fault and (iv) 3-Phase Fault.
2. Load flow analysis for a given system (for 3 to 6 bus) using (i) Gauss Seidal (ii) Newton Raphson (iii) Fast Decoupled Method and verify results using MATLAB or any available software.
3. Three phase short circuit analysis in a synchronous machine(symmetrical fault analysis)
4. Study of voltage security analysis.
5. Study of overload security analysis and obtain results for the given problem using MATLAB or any software.
6. Study of economic load dispatch problem with different methods.
7. Study of transient stability analysis using MATLAB/ETAP Software.
8. Power flow analysis of a slack bus connected to different loads.



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE4-22: ELECTRIC DRIVE LAB

Credit: 2
OL+OT+4P

Max. Marks: 100(IA:60, ETE:40)
End Term Exam: 3 Hours

1. Study and test the firing circuit of three phase half controlled bridge converter.
2. Power quality analysis of 3 phase half controlled bridge converter with R and RL loads.
3. Power Quality analysis of 3-phase full controlled bridge converter feeding R and RL load.
4. Study and obtain waveforms of 3-phase full controlled bridge converter with R and RL loads.
5. Experimental analysis of 3-phase AC voltage regulator with delta connected, star connected (with floating load), R& RL load
6. Control speed of dc motor using 3-phase half controlled bridge converter. Plot armature voltage versus speed characteristic.
7. Control speed of dc motor using 3-phase full controlled bridge converter. Plot armature voltage versus speed characteristic.
8. Control speed of a 3-phase induction motor in variable stator voltage mode using 3-phase AC voltage regulator.
9. Control speed of a 3-phase BLDC motor.
10. Control speed of a 3-phase PMSM motor using frequency and voltage control
11. Control speed of universal motor using AC voltage regulator.
12. Study 3-phase dual converter.
13. Study speed control of dc motor using 3-phase dual converter.
14. Study three-phase cyclo-converter and speed control of synchronous motor using cyclo-converter.
15. Control of 3-Phase Induction Motor in variable frequency V/f constant mode using 3-phase inverter.



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE4-23: POWER SYSTEM PROTECTION LAB

Credit: 1
OL+OT+2P

Max. Marks: 100(IA:60, ETE:40)
End Term Exam: 2 Hours

1. To determine fault type, fault impedance and fault location during single line to ground fault.
2. To determine fault type, fault impedance and fault location during single line-to-line fault.
3. To determine fault type, fault impedance and fault location during double line to ground fault.
4. To study the operation of micro-controller based over current relay in DMT type and IDMT type.
5. To analyse the operation of micro-controller based directional over current relay in DMT type and IDMT type.
6. To study the micro-controller based under voltage relay.
7. To study the micro-controller based over voltage relay.
8. To study the operation of micro-controller based un-biased single-phase differential relay.
9. To study the operation of micro-controller based biased single-phase differential relay.
10. To study the operation of micro-controller un-based biased three phase differential relay.
11. To study the operation of micro-controller based biased three phase differential relay.



RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

III Year - VI Semester: B.Tech. (Electrical Engineering)

6EE4-24: MODELLING AND SIMULATION LAB

Credit: 1
0L+0T+2P

Max. Marks: 100(IA:60, ETE:40)
End Term Exam: 2 Hours

1. Simulate Swing Equation in Simulink (MATLAB)
2. Modeling of Synchronous Machine.
3. Modeling of Induction Machine.
4. Modeling of DC Machine.
5. Simulate simple circuits.
6. (a) Modeling of Synchronous Machine with PSS (b) Simulation of Synchronous Machine with FACTS device.
7. (a) Modeling of Synchronous Machine with FACTS device (b) Simulation of Synchronous Machine with FACTS devices.
8. FACTS Controller designs with FACT devices for SMIB system.