B. Tech (Electrical Engineering)

SEMESTER –VI

Sl No.	Course Code	Course Title	Hours Per Week			Total Credits
			Lecture	Tutorial	Practical	
1.	100606	Digital Signal Processing	3	0	0	3
2.	100607	Introduction to VLSI Design	3	0	0	3
3.	100608	Professional Skill Development	3	0	0	3
4.	103601	Power Systems – II (Operation and Control)	3	0	0	3
5.	1036xx	Program Elective-II	3	0	0	3
6.	1036xx	Program Elective-III	3	0	0	3
7.	100606P	Digital Signal Processing Lab	0	0	2	1
8.	100607P	Introduction to VLSI Design Lab	0	0	2	1
9.	103601P	Power Systems-II Lab	0	0	2	1
10.	100609P	Electronics Design Laboratory	0	0	4	2
11.	100604P	NPTEL Courses-2 Lab	0	0	4	2
TOTAL						25

List of Program Elective Courses

SL NO.	Course Code	Course Title	Remarks
1.	100611	Computer Architecture	Elective-I
2.	100612	Digital Control Systems	Elective-I
3.	100613	Electrical Drives	Elective-I
4.	103605	High Voltage Engineering	Elective-II
5.	103606	Industrial Electrical Systems	Elective-II

SEMESTER – VI

Course Code- 100606 Digital Signal Processing 3 0 0 3

Unit-1.0: 6 hrs

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.

Unit-2.0: 6 hrs

Z-transform: Z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.

Unit-3.0: 9 hrs

Discrete Fourier Transform: Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Connvolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.

Unit-4.0: 9 hrs

Design of Digital filters: Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band-stop and Highpass filters.

Unit-5.0: 6 hrs

Effect of finite register length in FIR filter design, Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing.

Unit-6.0: 6 hrs

Applications of Digital Signal Processing: Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.

Text/ Reference:

1. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
2. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
3. J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Prentice Hall, 1997.
4. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
5. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
6. D. J. DeFatta, J. G. Lucas andW. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

B.Tech (Electrical Engineering) **Semester-VI**

Course Code- 100607 Introduction to VLSI Design 3 0 0 3

Unit-1.0 **9 hrs**

Introduction MOSFET, threshold voltage, current, Channel length modulation, body bias effect and short channel effects, MOS switch, MOSFET capacitances, MOSFET models for calculation- Transistors and Layout, CMOS layout elements, parasitics, wires and vias-design rules-layout design SPICE simulation of MOSFET I-V characteristics and parameter extractio**n**.

Unit-2.0 **9 hrs**

CMOS inverter, static characteristics, noise margin, effect of process variation, supply scaling, dynamic characteristics, inverter design for a given VTC and speed, effect of input rise time and fall time, static and dynamic power dissipation, energy & power delay product, sizing chain of inverters, latch up effect-Simulation of static and dynamic characteristics, layout, post layout simulation.

Unit-3.0 **8 hrs**

Static CMOS design, Complementary CMOS, static properties, propagation delay, Elmore delay model, power consumption, low power design techniques, logical effort for transistor sizing, ratioed logic.

Unit-4.0 **7 hrs**

pseudo NMOS inverter, DCVSL, PTL, DPTL & Transmission gate logic, dynamic CMOS design, speed and power considerations, Domino logic and its derivatives, C2MOS, TSPC registers, NORA CMOS – Course project.

Unit-5.0 **5 hrs**

Circuit design considerations of Arithmetic circuits, shifter, CMOS memory design - SRAM and DRAM.

Unit-6.0 **4 hrs**

BiCMOS logic - static and dynamic behaviour -Delay and power consumption in BiCMOS Logic.

Text/ Reference:

1. Principles of CMOS VLSI design: a system perspective by Neil H.E. Weste and Kamran Eshraghian; Addision Wesley pub.
2. Digital integrated circuits by Demassa & Ciccone. Wiley pub.
3. Modern VLSI Design system on silicon by Wayne Wolf: Addision Wesley Longman Publisher.
4. Basic VLSI Design by Douglas A Pucknell & Kamran Eshranghian; PHI 5 Digital Integrated Circuits: A Design Perspective by Jan M Rabaey; PHI

B.Tech (Electrical Engineering) **Semester-VI**

Course Code- 100608 Professional Skill Development 3 0 0 3

Unit-1.0 **8 hrs**

Communication skills: Public speaking, Group discussion, Gestures and body language & professional presentation skills

Unit-2.0 **7 hrs**

Interpersonal skills: Group dynamics, Negotiation skills, Leadership, Emotional intelligence

Unit-3.0 **8 hrs**

Employability and Corporate Skills I: Time management and effective planning, Stress management, People skills, Team work, development of leadership qualities,

Unit-4.0 **8 hrs**

Employability and Corporate Skills II:Decision making and Negotiation skills, Positive attitude, Self-motivation, Professional ethics, Business etiquettes, balancing board room.

Unit-5.0 **7 hrs**

Business writing skills, Resume Writing Interview Skills, Technical Presentation, Guest Lecture.

Unit-6.0 **4 hrs**

Professional Ethics, Project Management, Entrepreneurship.

Text/ Reference:

1. "Personality Development and Soft Skills", Barun Mitra, Oxford University Press.
2. "Managing Soft Skills for Personality Development", B.N. Ghosh, McGraw Hill.
3. "Communication Skills and Soft Skills: An Integrated Approach", E. Suresh Kumar, Pearson
4. "Communication to Win", Richard Denny, Kogan Page India Pvt. Ltd.

B.Tech (Electrical Engineering) **Semester-VI**

Course Code- 103601 Power Systems – II 3 0 0 3

Unit-1.0: Power Flow Analysis 8 hrs

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 non-linear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.

Unit-2.0: Stability Constraints in synchronous grids 8 hrs

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 constraintson Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability.

Unit-3.0: Control of Frequency and Voltage I 6 hrs

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.

Unit-4.0: Control of Frequency and Voltage II 6 hrs

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.

Unit-5.0: Monitoring and Control 6 hrs

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

Unit-6.0: Fault Analysis and Protection Systems 8 hrs

Method of Symmetrical Components (positive, negative and zero sequences). Balanced and Unbalanced Faults. Representation of generators, lines and transformers in sequence networks. Computation of Fault Currents. Neutral Grounding.

Text/ Reference:-

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education,1995.
3. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc.,1999.
4. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.

B.Tech (Electrical Engineering) **Semester-VI**

Program Elective-II

Course Code- 100611 Computer Architecture 3 0 0 3

Unit-1.0: Introduction to computer organization 6 hrs

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.

Unit-2.0: Memory organization 6 hrs

System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.

Unit-3.0: Input – output Organization 8 hrs

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.

Unit-4.0: 16 and 32 microprocessors 8 hrs

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

Unit-5.0: Pipelining 8 hrs

Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.

Unit-6.0: Different Architectures 6 hrs

VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming

Text/Reference:

1. V. Carl, G. Zvonko and S. G. Zaky, **"**Computer organization**"**, McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, **"**The Intel microprocessors**"**, Pearson Education, 2000.
3. J. L. Hennessy and D. A. Patterson, **"**Computer Architecture A Quantitative Approach**"**, Morgan Kauffman, 2011.
4. W. Stallings, **"**Computer organization**"**, PHI, 1987.
5. P. Barry and P. Crowley, **"**Modern Embedded Computing**"**, Morgan Kaufmann, 2012.
6. N. Mathivanan, **"**Microprocessors, PC Hardware and Interfacing**"**, Prentice Hall, 2004.
7. Y. C. Lieu and G. A. Gibson, **"**Microcomputer Systems: The 8086/8088 Family**"**, Prentice Hall India, 1986.
8. J. Uffenbeck, **"**The 8086/8088 Design, Programming, Interfacing**"**, Prentice Hall, 1987.
9. B. Govindarajalu, **"**IBM PC and Clones**"**, Tata McGraw Hill, 1991.
10. P. Able, **"**8086 Assembly Language Programming**"**, Prentice Hall India.

B.Tech (Electrical Engineering) **Semester-VI**

Course Code- 100612 Digital Control Systems 3 0 0 3

Unit-1.0: Discrete Representation of Continuous Systems 6 hrs

Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

Unit-2.0: Discrete System Analysis 6 hrs

Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.

Unit-3.0: Stability of Discrete Time System 4 hrs

StabilityanalysisbyJurytest.Stabilityanalysisusingbilineartransformation.Designofdigitalcontrol system with dead beat response. Practical issues with dead beat response design.

Unit-4.0: State Space Approach for discrete time systems 10 hrs

State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.

Unit-5.0: Design of Digital Control System 8 hrs

Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.

Unit-6.0: Discrete output feedback control 8 hrs

Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.

Text/Reference:

1. K. Ogata, “Digital Control Engineering”, Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, “Digital Control Engineering”, Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, “Digital Control of Dynamic Systems”, Addison-Wesley, 1998.
4. B.C. Kuo, “Digital Control System”, Holt, Rinehart and Winston, 1980.

B.Tech (Electrical Engineering) **Semester-VI**

Course Code- 100613 Electrical Drives 3 0 0 3

Unit-1.0: 6 hrs

DC motor characteristics: Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change into rque-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.

Unit-2.0: 6 hrs

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.

Unit-3.0: 6 hrs

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.

Unit-4.0: 7 hrs

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.

Unit-5.0: 7 hrs

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.

Unit-6.0: 10 hrs

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.

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.

Text/Reference:

1. G. K. Dubey, “Power Semiconductor Controlled Drives”, Prentice Hall,1989.
2. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice Hall, 2001.
3. G. K. Dubey, “Fundamentals of Electrical Drives”, CRC Press, 2002.
4. W. Leonhard, “Control of Electric Drives”, Springer Science & Business Media, 2001.

B.Tech (Electrical Engineering) **Semester-VI**

Course Code- 103605 High Voltage Engineering 3 0 0 3

Unit-1.0: 8 hrs

Breakdown in Gases: Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge.

Unit-2.0: 7 hrs

Breakdown in liquid and solid Insulating materials: Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.

Unit-3.0: 7 hrs

Generation of High Voltages: Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.

Unit-4.0: 7 hrs

Measurements of High Voltages and Currents: Peak voltage, impulse voltage and high direct current measurement method, cathode ayoscillo graphs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.

Unit-5.0: 6 hrs

Lightning and Switching Over-voltages: Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching over-voltages, Protection against over-voltages, Surge diverters, Surge modifiers.

Unit-6.0: 7 hrs

High Voltage Testing of Electrical Apparatus and High Voltage Laboratories: Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings,testingofisolatorsandcircuitbreakers,testingofcables,powertransformersandsomehigh voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V.Labs.

Text/Reference:

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education,2013.
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers,2007.
3. D. V. Razevig (Translated by Dr. M. P. Chourasia), "High Voltage Engineering Fundamentals", Khanna Publishers,1993.

B.Tech (Electrical Engineering) **Semester-VI**

Course Code- 103606 Industrial Electrical Systems 3 0 0 3

Unit-1.0: Electrical System Components 8 hrs

LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices.

Unit-2.0: Residential and Commercial Electrical Systems 8 hrs

Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Unit-3.0: Illumination Systems 6 hrs

Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Unit-4.0: Industrial Electrical Systems I 8 hrs

HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

Unit-5.0: Industrial Electrical Systems II 6 hrs

DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Unit-6.0: Industrial Electrical System Automation 6 hrs

Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

Text/Reference:

1. S.L. Uppal and G.C. Garg, “Electrical Wiring, Estimating & Costing”, Khanna publishers, 2008.
2. K. B. Raina, “Electrical Design, Estimating & Costing”, New age International, 2007.
3. S. Singh and R. D. Singh, “Electrical estimating and costing”, Dhanpat Rai and Co., 1997.
4. Web site for IS Standards.
5. H. Joshi, “Residential Commercial and Industrial Systems”, McGraw Hill Education, 2008.

B.Tech (Electrical Engineering) **Semester-VI**

Course Code- 100606P Digital Signal Processing Lab 0 0 2 1

Perform all Experiments

List of Experiments:

1. To represent basic signals (Unit step, unit impulse, ramp, exponential, sine and cosine).
2. To develop program for discrete convolution
3. To develop program for discrete correlation
4. To understand stability test
5. To understand sampling theorem
6. To design analog filters (low-pass, high pass, band pass, band stop)
7. To design digital filters (low-pass, high pass, band pass, band stop)
8. To design fir filters using windows techniques

B.Tech (Electrical Engineering) **Semester-VI**

Course Code-100607P Introduction to VLSI Design Lab **0 0 2 1**

Hands-on/Computer experiments related to the course contents of Introduction to VLSI Design theory.

B.Tech (Electrical Engineering) **Semester-VI**

Course Code- 103601P Power Systems-II Lab **0 0 2 1**

Hands-on/Computer experiments related to the course contents of Power Systems-II theory.

B.Tech (Electrical Engineering) **Semester-VI**

Course Code- 100609P Electronics Design Laboratory 0 0 4 2

Perform all Experiments

Students will demonstrate the ability to

- Understand the practical issues related to practical implementation of applications using electronic circuits.
- Choose appropriate components, software and hardware platforms.
- Design a Printed Circuit Board, get it made and populate/solder it with components.
- Work as a team with other students to implement an application.

List of Experiments:

1. Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits.
2. Introduction to electronic instrumentation and PC based data acquisition; Electronic system design, Analog system design.
3. Interfacing of analog and digital systems, Embedded systems, Electronic system design employing microcontrollers, CPLDs, and FPGAs, PCB design and layout; System assembly considerations.
4. Group projects involving electronic hardware (Analog, Digital, mixed signal) leading to implementation of an application.

Text/ Reference:-

1. S. Sedra and K. C. Smith, “Microelectronic circuits”, Oxford University Press, 2007.
2. P. Horowitz and W. Hill, “The Art of Electronics”, Cambridge University Press, 1997.
3. H. W. Ott, “Noise Reduction Techniques in Electronic Systems”, Wiley, 1989.
4. W.C. Bosshart, “Printed Circuit Boards: Design and Technology”, Tata McGraw Hill,
5. 1983.
6. G.L. Ginsberg, “Printed Circuit Design”, McGraw Hill, 1991.