Description for basic and technical courses
B.Sc. Degree in Electrical Engineering, Control and Instrumentation
Sharif University of Technology
Electrical Engineering Department
Fall Semester 1986-87

General Math I

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	22-015	General Math I	4	17	4	0	1.5

* Prerequisite: None

- The Cartesian and Polar Coordinates
- Complex numbers; sum, product, root and geometric presentation of complex numbers, complex numbers in polar coordinates
- Functions and function algebra
- Limits, infinite limits, limits in infinities theorem, left and right limit, and continuity
- Derivation, inverse functions and their derivation, derivation of trigonometric and their inverse function
- Rolle's and the mean-value theorem, Taylor's expansion
- Physical and geometrical application of derivatives
- Curves and acceleration in polar coordinates
- Application of derivatives in equation root
- Definition of integral theorem (for continuous and semi-continuous functions),
- The fundamental principals of differential and integral calculus
- Approximation methods for calculating integrals
- Application of integral in calculating area, volume, length of curves, torque, center of gravity, work,.. (in Cartesian and Polar coordinates)
- Exponential and logarithmic functions and their derivatives
- Integrals of Hyperbolic functions
- Some special techniques in integral by variable substitution, part by part, and dividing the fractions
- Special variable substitution in numeric and geometrical series and principles
- Geometrical series and Taylor's principle with residue

General Physics I

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	24-015	General Physics I	4	17	4	0	1.5

* Prerequisite: General Math I or same time

Motion in one dimension, Free fall, Vectors, Motion in two dimensions, Projectile motion, Relative motion, The laws of motion, Friction, Circular motion and other applications of Newton's laws, Work and energy, Potential energy and conservation of energy, Moment of Inertia, Linear momentum and collisions, conservation of linear momentum, The centre of mass/gravity, Torque, Rotation of a rigid object about a fixed axis, Rotational kinematics, Angular momentum, Static equilibrium, Dynamics of a particle, elastic and non elastic collisions, rotational kinematics and dynamics, Oscillations, Vibration and waves.

General Workshop

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	33-018	General Workshop	1	17	0	3	0

* Prerequisite: None

Introduction to molding tools, Safety and security rules in molding and melting, Sand casting and pattern, Introduction to welding safety factors, Welding and cutting acetylene gas, Welding by electrical spark and its tools, Soldering and resistance welding, Using different tools of sheet metal forming, metal strap forming, Making duct and pipes and fittings by sheet metal forming, Piping, Classification of machine tools and their safety and security rules, Sawing: Using reciprocating, horizontal and vertical sawing machines, Boring: Safety rules, Different types of drilling machines and drilling tools, Sharpening bits, Definition and geometry of a cutting tool, Introduction to Sanding and the Safety rules, Electrical wiring, Introduction to combustion engines and auto-mechanics.

Engineering Graphics

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	35-311	Engineering Graphics	2	17	1	2	0

* Prerequisite: None

Drawing projection of points and lines and planes and objects on the drawing plane, Description of principle planes of a drawing, Principles of drawing three views, Geometrical relation between different views, Different types of lines and their application, Geometrical figures, Different ways of describing the first and third angle projection, Ways of drawing three views of an object in the third angle projection, Ways of drawing six views of an object in the first angle projection, Transforming angle projection, Drawing the image of an object using defined views, Different types of sectional views, Exceptions in sectional views, Definition of perspective and its applications, Types of perspectives, Orthographic perspectives (Isometric, Dimetric, and Thrimetric), Angled isometric (Cavalier) and angled diametric (Cabinet) perspective, Standard method of drawing joints and fasteners (bolts, nuts, and welding), Ways of drawing assembled parts (in brief).

** Instructor should try to introduce the related CAD software packages to students in this course.

Static and Strength of Materials

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	20-915	Static and Strength of Materials	3	17	3	0	1

* Prerequisite: General Math I and General Physics I

Stress: Definitions, Tensor of stress in beams under axial loading (forces), Shear stress, Allowed shear stress in fastenings and their safety factors.
Strain and Deflection under axial loading: definition of strain and its relation with strain, Strain and stress diagrams for different materials, Thermal strain, Poisson ratio, Hook's law and general equations for homogenous and isotope materials volumic strain and Young's Modules.
Torsion: Definition of Torsion, Torsion formulas for shear stress and angle of twist, Axial force, shear force and bending moment in beams, Calculating internal forces using section method, Plastic torsion of circular bars.
Pure Bending (flexure): Definition and basic concepts, Curvature (bending) formula, Section moment, Stress formula under pure bending, Concentrated stress bending in beams with unsymmetrical sections, Combined bending under unsymmetrical axial loading.

General Math II

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	22-016	General Math II	4	17	4	0	1.5

* Prerequisite: General Math I

Parametric functions, 3D coordinates and vectors in space, The dot product, Systems of linear equations with 3 variables (3x3 matrixes), Row operations in matrixes and inverse of matrix, Solutions of systems of equations, Linear independence, Base in R2 and R3, Linear transformation and its matrix, 3x3 Determinants, Eigen value and eigen vector , The cross product, line equation and surface (second order) equation, Vector function and its derivation, Velocity and acceleration, Curves and perpendicular vectors to the curve, Multi-variables functions, Directional and partial derivatives, Tangent plane to a surface and normal gradient line, The chain rule for partial derivatives, Exact differentials, Double and triple integrals and their applications in geometry and physics, Change in sequence of integration, Cylindrical and spherical coordinates, Vector field, Curve line and surface integral, Divergence, Surfaces of revolution, Laplace transformation, Green’s theorem in the plane, Stock’s theorem, Divergence theorem.

Engineering Probability and Statistics

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	22-063	Engineering Probability and Statistics	3	17	3	0	1

* Prerequisite: General Math I

Descriptive statistics:
Population, Sample, Variable, Data, Types of statistical data, Frequency table of data, Drawing of statistical charts, Histograms, Frequency, Cumulative frequency

Probability theory:
Random trials, Sample space, Events, probability changes using relative and classic and individual frequency, Probability model, Probability model uniform, probability calculations, Definition of probability, Principles of probability, Conditional probability, Biz formula, Independence of events, Random variable, Types of one-dimensional random variable, Distributions, Random variables, Types of continuous and discrete random variables and calculating their probability, Mathematical hope, Standard deviation, Two-dimensional random variables and their probability functions, Correlation, Correlation coefficients, Independence for random variables, Confidence intervals, Probability experiments, Introduction of regression.

Physics II

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	24-988	Physics II (Electricity & Magnetism)	2	17	2	0	1

* Prerequisite: General Physics I

- *Charge and object:* Electric charges (quality of electricity), Conductors, Dielectric, Coulomb's law
- *Gauss's law:* Gauss's law and it's relation with coulomb's law, Electric field strength, Some applications of Gauss's law
- *Electric potential:* Electric potential of discrete charge, Dipole's potentials, Energy of electric potentials, Calculation of electric potential difference
- *Capacitors:* Capacitance, Calculation of energy in capacitor circuits, Dielectric constant (Permeability)
- *Electric current and resistance:* Current, Resistance (specific electric conductivity), Ohm's law, Energy transfer in electric circuits
- *EMF (Electric motive force):* Calculation of electric current strength, Potential difference, Multi-turns circuits, Measuring of current and potential difference, RL circuits, Resistor circuits, Kirichhoff's law, Basic features of ammeter and voltmeter, potentiometer and Wattson's bridge
- *Electric Field:* Force lines, Discrete charge, Dipole in Electric Field.
- *Magnetic field:* Magnetic Induction, Magnetic flux, Force on current in Magnetic fields, Hall effect, Moving electric charge
- *Ampere's law:* Magnetic field around a long wire, Magnetic field lines
- *Faraday's law:* Faraday's experiment, Lens's law, Induction, Time-changing Magnetic fields
- *Electromagnetic:* Analysis of simple Pendulum's motion, Magnitude of electromagnetic oscillations, Change in electromagnetic current

Computer Programming

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	40-111	Computer Programming	2	17	2	1	0

* Prerequisite: General Math I

1- Introduction and History of Computers
2- Hardware components (CPU, Main memory and peripheral)
3- Programming language and its different types (Machine code, Assembly, High-level languages)
4- Introduction of software and its different types (Operating systems, Compilers and application programs)
5- Steps of solving the problem: Definition of problem, Analysis of problem, Dividing the problem into smaller problem and determining the relations
6- Algorithm: Definition, Generalizing the solution and designing the algorithm, presentation of algorithm using flow chart, Coding and follow up the algorithms, Sub-algorithm concept
7- Programming and problem solving: Definition of program, General structure of the program, Basic structures in programming
8- Logical Structure: Sequences and order, Repetition (loops), If and conditional statements, Recursive concept
9- Structure of data (Different types of data: Real, Integer, Boolean/Characters; Different complicated data types: Arrays, Records, Sets
10- Subroutines (Methods for transferring parameters between subroutines)
11- Introduction to the concept of files (File processing, Input and output operations)

Concepts above should be taught in Pascal, Fortran 77 (or higher) or C programming language
At least two programming project should be included.

Differential Equation

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	22-034	Differential Equation	3	17	3	0	1

* Prerequisite: General Math II or same time

Introduction to differential equation and its solution, Curve and straight routes, Physical and population models of differential equations, Equation with variable separable, First order linear differential equations, Homogeneous equations, Second order differential equations, Homogeneous equations with constant coefficients, The method of undefined coefficients, The method of variation of parameters, Application of second order equation in physics and mechanics, Series solution of differential equations, Bessel's and Gama equations, Legendre's polynomial, Introduction to the differential equations systems, Laplace transform and it applications in solving differential equation

Numerical Computation

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	22-071	Numerical Computation	2	17	2	0	1

* Prerequisite: General Math II, Differential Equation

Errors and their sources, interpolation and extrapolation, Different numerical methods for solving equations, Numerical methods for differentiation and integrations, limited differences, Numerical methods for solving ordinary first and second order differential equations, Operations on matrix and finding matrix eigen values, Solving systems of linear and non-linear equations, Minimum squares method.

Circuit Theory

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-021	Circuit Theory	4	17	4	0	1.5

* Prerequisite: General Math I

Lumped circuits and Kerchief's laws, Estimation and modeling of circuit elements, Circuit components: resistors, independent and dependent (voltage and current) sources, capacitors, inductors, Power and energy, Operational Amplifiers as a component of the circuit, Simple circuits such as resistor circuits, Method of analyzing resistor circuits, Characterizing a circuit from its two ports, Thevenin's and Norton's equivalent circuits and superposition for resistor circuits, Converting sources, Connecting capacitors and inductors together, First order circuits such as RL and RC circuits, Response to zero input, Response to zero state, Transient and steady state responses, Time constants, Circuits with multiple time constants, Switching, Step and impulse response, Second order circuits, Stability concept, Oscillation, Negative resistance, Dual circuits, Analogy between electrical and mechanical systems, Methods for analyzing linear circuits (node and mesh analysis), Importance of impulse response and its calculation for general linear circuits (Time domain analysis), Convolution theorem

Network graphs, Concept of lope and cut-set expressed in matrix, Telegan principle, Input impedance characteristics, Methods analyzing of node and mesh for general linear circuits including representing matrix form of node and mesh equations using classic, heuristic and shortcut methods, graphs and dual circuits, concept of tree and branch and their relations in defining independent lopes and cut-sets in a graph, Determining independent branch voltage and current variables in a circuit, State space method, matrix representation of state equations, Determining the estimated state space path and state equation in linear and non-linear circuits, Laplace transform and its applications, Frequency domain analysis for electrical circuits, Basic characteristics of linear time-invariant circuits, Natural frequencies of a network, A network variable and determining it in both time and frequency domain, Network functions and its poles and zeros, Determining frequency response (drawing method, Bode diagrams), Basic analysis of network theorems including substitution principle, superposition principle, Thevenin's and Norton's equivalent principle, reciprocity principle in different forms, Two-pole networks and methods to determining two-pole networks with T, H, Y and Z parameters, Connecting two-pole networks, Multi-pole networks.

Alternating current circuits

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-022	Alternating current circuits	2	17	2	0	1

* Prerequisite: Circuit Theory or same time

Analysis sinusoidal steady state: Impedance phasor concept, Admittance, Phasor diagram, resonance concept, parallel and series resonating circuits, Network functions, Frequency response, Power in sinusoidal steady state, Average , real and reactive power, Maximum power transfer principle, Effective and RMS values, Changing scale of a circuit, Node and mesh analysis, Analyzing balanced 3-pahse circuits, Coupling and coupled circuits, Equivalent T and Π for coupled inductors, Inductance matrix, connecting coupled inductors together, transformers, circuit model, characteristics and applications

Electromagnetic

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-042	Electromagnetic	3	17	3	0	1

* Prerequisite: Physics II (Electricity & Magnetics)

Vector mathematics: Vectors and scalars, Four basic operations on vectors, Unity vectors and components of a vector, Conversion of vectors between different coordinates, Integration of vector functions, Linear integral, Surface integral, Derivation of vector functions, Divergence, Curl, Slope or gradient of derivation of vector functions, Gauss law, Stocks theorem, Helmholtz principle, Slope equations, Laplacian, Divergence and curl in different coordinates, Important vector principles.

Laws of electrostatics in vacuum: Coulomb's law, Electrostatic field and its intensity, Electrostatic field intensity of a charged line with uniform density, Electrostatic field intensity of charged surface with uniform density, Electrostatic flow and Coulomb's law, Electrical potential, Accumulated energy in a Electrical field, Electrical Bi-pole.

Electrostatics in insulation: Polarization in insulations, Electrical fields due to polarized in insulations, Limit conditions at the border of two insulations, insulation.

Electrostatics in environments with conductors: Conductors in uniform electrostatic fields, Elimination of conductors and converting problems to problems in Vacuum, Limit conditions at the surface border between conductors and insulation, Projection methods, Point charge in front of a infinite conducting surface, Point charge in front of a conducting grounded sphere, Point charge in front of a conducting un-grounded sphere, Method of solving problems with known potentials at the limiting surfaces, 3D problem in Cartesian coordinates, 3D problem in Polar coordinates, Numerical estimated methods for solving electrostatics problems, Capacitors and definition of their capacity, Protective characteristics of conductors.

DC electrical current in environments with conductors: Conducting electrical current, Current density and total current, The law of conservation of charge, Non-conservative electrical fields and motive force, Ohm's law, Limit condition for current density vector, Joule's law, Reduction of electrical charge inside conductors.

Magnetic filed in vacuum: Ampere's law, Magnetic density flow B and Biot-Savart's law, Magnetic potential vector, Divergence of magnetic density flow, Curl of magnetic density flow, Ampere's circuit law, Magnetic Bi-pole.

Magnetic fields in environments with magnetic objects: Types of magnetic objects, Magnetic fields produced by to magnetic objects and equivalent current, Magnetic field intensity H, Permeability of magnetic objects, Limit conditions on vectors B, H MH and magnetic circuits and magnetic resistance, Magnetic cure of Ferro-magnetic objects.

Circuit and Measurement Lab

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-008	Circuit and Measurement Lab	1	17	3	0	0

* Prerequisite: Electrical Measurements or same time

In accordance with subjects taught in the Electrical Measurements and Circuit Theory course

Electrical Measurements

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-013	Electrical Measurements	3	17	3	0	1

* Prerequisite: Electric Circuits I

Concepts and importance of electrical measurement, Primary definitions, Components of measurement systems, Errors and error analysis, Classification of measurement equipment, Ordinary oscilloscope and recorders, Analogue measuring equipment (permanent magnet with moving winding and visa versa, moving iron, electro-dynamic, inductive ferro-dynamic, electrostatic), Measurement devices for DC and AC current and voltages, Methods of measuring very low and very high values of voltage and current, Measuring equipment with multipliers, Single and three-phase active and reactive power meters, Measurement of resistance, capacitance, inductance and Q, measurement bridges and their applications, transducers, digital measuring equipment, Frequency and harmonics measurement, Advanced oscilloscopes, Miscellaneous measurement equipment such as SVTVM, VTVM, Cure tracers, wave analysers, …

Electronics I

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-031	Electronics I	3	17	3	0	1

* Prerequisite: Circuit Theory

N and P type semiconductors: Current and voltage equations for diodes, diode equivalent circuit, …
Diode circuits: Half-wave and full-wave rectifier models, Clipping circuits, clamping circuits, …
Study of transistor: Biasing and stabilizing operating points for various transistor circuit configurations, Low frequency and small signal equivalent circuits for transistors, Using transistor as a single-stage amplifier, Introduction to transistor as a switch
Study of JFET in various circuit configurations: Biasing, Equivalent circuit and using JFET as amplifier
MOS transistor: E,D models, Study of N-MOS, P-MOS, C-MOS
UJT transistor and its applications in ramp generators, Four-layer diodes: Analysis of current versus voltage characteristics

Logic & Switching Circuits

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-521	Logic & Switching Circuits	3	17	3	0	1

* Prerequisite: Electronics I or same time

Number system, Boolean algebra and related rules, Logic functions and simplification, Logic gates (RTL, DTL, TTL) and related calculations (Fanin, Fanout, …), Design of combinational circuits (comparators, coders, decoders, adders, …), Sequential circuits (flip flops, shift registers, counters, synchronous and asynchronous logic circuits and troubleshooting), Comparison of different technologies (TTL, MOS, …)

Engineering Mathematics

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	22-035	Engineering Mathematics	3	17	3	0	1

* Prerequisite: General Math II

- Fourier series and its integral, Fourier transform: Definition of Fourier series, Euler's formula, Half range expansion, Forced vibration, Fourier integration, Laplace transform
- Partial differential equations: Vibrating string, Single variable wave equation, Method of separating variables, Delabre solution for wave equation, Equation for diffusion of heat, separation of variables methods, Two variable wave equation, Laplace's equation in Cartesian, Spherical and Polar coordinates, Hyperbolic and parabolic equations, Uses for Laplace transform in solving partial differential equations, Solving partial differential equations using Fourier integral
- Analytical functions and conformal mappings and complex integrals: Limits and continuity, Derivative of complex functions, Exponential, trigonometric, logarithmic, hyperbolic, inverse trigonometric and exponential with complex exponent functions, Conformal mapping
- Line Integral in complex plane, Cauchy's integral theorem, Calculating line integral using indefinite integrals, Cauchy's formula, Taylor and Mac-Laurent series, Integration by residue method ,The residue theorem, Evaluation of real integrals

Physics Lab I

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	24-001	Physics Lab I	1	17	0	3	0

* Prerequisite: General Physics I

In accordance with the subjects taught in the General Physics I course.

Electronics Lab I

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-002	Electronics Lab I	1	17	0	3	0

* Prerequisite: Electronics I, Circuit and Measurement Lab

Compliant with the subjects taught in the Electronics I course
Familiarization with diodes and their volt-ampere characteristics, diode applications in rectifiers, diode applications as clipper, clamper and limiter, voltage multipliers, familiarization with transistors, such as their types, measurement of leakage currents (ICBO, ICEO, ICES) and input/output characteristics, curves of transistors (such as PNP and NPN), determination of n parameters by transistor characteristics, investigation of active states of transistors (cut-off, saturation, operating point), transistor amplification in configurations of common-emitter, common-collector and common-base, Darlington amplifiers, simple power supplies using zener diode and transistors.

Electronics II

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-032	Electronics II	3	17	3	0	1

* Prerequisite: Electronics I

Cascaded amplifiers (using BJT and FET transistors), Power amplifiers, Current sources, Using feedback in amplifiers, DC amplifiers, differential amplifiers, operational amplifiers, Introduction to offset in Op-Amps and methods of compensation, Various applications of Op-Amps (e.g. stabilized voltage and current sources, oscillators, …)

Signal & Systems

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-051	Signal & Systems	3	17	3	0	1

* Prerequisite: Circuit theory and Alternating current circuits

Primary definitions: System and signal, Different types of systems, Introduction to modeling of various physical systems
Analysis of linear and time invariant (continuous and discrete) systems: Impulse response, Convolution integral, Fourier analysis, Energy and power density Spectrum, Sampling theorem
System analysis using Laplace transform: block diagram, signal flow graphs
System analysis in state space (continuous and discrete), Z transform, Discrete systems analysis using the Z transform .

Electrical Machines I & II

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-063	Electrical Machines I & II	4	17	4	0	1.5

* Prerequisite: Circuit theory or Electric Circuits I

Introduction to electrical machines, General principles and definition of conversion of electrical, Electromagnetic and mechanical energy Electromagnetic circuits and general equations, Electromagnetic coupled circuits, Transformers and general equations, Equivalent circuit for ideal transformer, Equivalent circuit for real transformers, Accumulated energy in electromagnetic fields, General relations between torque and applied force and changes in accumulated electromagnetic energy and its application in different types of electrical machines
Principles of DC machines in ideal conditions, Types of regular DC machines, Mathematical model
Principles of synchronous AC machines in the simplest conditions, Park equations, Mathematical model in the steady state condition
Principles of asynchronous AC machines, Equivalent circuit and characteristics in the steady state condition
Single-phase transformer, Voltage equations, Equivalent circuit, Parallel connection of transformers, Three-phase transformers, Magnetic circuits, Electrical circuits, Transformers with three windings, Transformer temperature, Insulations, Cooling, Loss and efficiency of a transformer, Transformer temperature, DC machines, Ring and cylindrical type windings, Voltage equations, Torque calculations, Connections and steady state performance of DC machines, Curve and characteristics of DC machines, Rotating fields of three-phase windings, Conditions for generating torque in electrical machines, Synchronous machines with cylindrical rotor, Circular diagrams of synchronous machines, Equations for synchronous machines based on two-axis theory, Synchronous machine with salient-pole rotors, Circular diagrams of three-phase asynchronous machines, Asynchronous machines with cage rotors, Windings and coefficients.

Logic & Switching Lab

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-502	Logic & Switching Lab	1	17	0	3	0

* Prerequisite: Logic & Switching Circuits

In accordance with the subjects taught in the Logic & Switching Circuits course.

Communication Systems I

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-111	Communication Systems I	3	17	3	0	1

* Prerequisite: Signal and Systems

Introduction to basic telecommunications concepts and systems, Review of continuous-time signals and systems, Frequency spectrum, Analog communications: AM and FM, Analysis and implementation of amplitude modulation, Analysis and implementation of frequency modulation, Modulation techniques (DSB-SC, SSB), Frequency conversion, Characteristics of transmitters and receivers, Principles of super heterodyne communication systems, Multiplexing and de-multiplexing, Noise and distortion, Linearity, Energy and power spectra and signal-to-noise ratio analysis, Antennas and wave propagation

Power Systems Analysis

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-311	Power Systems Analysis	3	17	3	0	1

* Prerequisite: Electrical Machines I & II or at the same time

Introduction to power systems and related problems, Introduction to the parameters of power lines, One-line diagram of the power systems, Values relative to the P.U. unit, Electrical power distribution, Economical distribution of electrical power, Electrical energy distribution

Control Systems

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-411	Control Systems	3	17	3	0	1

* Prerequisite: Electrical Machines I & II and Signal & Systems

Applications of feedback, Feedback systems modeling, Definition of stability, Transfer function, Zeros and poles of transfer function and their presentation on complex coordinates, Criteria of system efficiency in transient and steady state, Types of system, Servo-mechanism and P, PI and PID controllers, Stability analysis using Routh-Hurwits and continued fractions method, Root-locus analysis method, Frequency response and Bode diagram, Polar diagram and Nyquist method, M and α diagrams and their applications, Estimated methods for simplifying high-order systems, System analysis in state space, Designing control systems and compensator, Analogue modeling, Discrete systems and analyzing them.

General Thermodynamics

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	28-165	General Thermodynamics	3	17	3	0	1

* Prerequisite: None

1- **Definitions:** Definition and history of Thermodynamics, Thermodynamic systems and characteristic volume (control volume), Properties and status of material, Process and cycle, Zeroth law of thermodynamic, temperature units
2- **Properties of pure material:** Equilibrium between three phase (gas, liquid and solid), The equation of state for ideal and real gases, Tables of thermodynamic properties, Bibbs phase principle
3- **Work and heat:** Definition of work, Movement work at the border of a compressible system in a pseudo-equilibrium process, Definition of heat, Comparing work and heat
4- **First law of thermodynamics:** First law of thermodynamics for a system with a circulation in one cycle, First law of thermodynamics for a system with phase change, Internal energy, Conservation of mass, First law of thermodynamics for characteristic volume, Enthalpy, uniform state, Process with uniform flow, Uniform state, Process with constant flow, Specific heat in constant volume, Specific heat in constant pressure, Pseudo-equilibrium process in constant pressure system, Internal energy, Enthalpy and specific heat for ideal gases
5- **Second law of thermodynamics:** thermal machines and refrigerators, Yield and efficiency, Second law of thermodynamics, Reversible process, causes for irreversibility of a process, Carnot cycle, Efficiency of Carnot cycle, Thermodynamic principle of temperature
6- **Entropy:** Clausius equation, Entropy, Pure material, Changes in entropy in reversible process, Changes in entropy in irreversible process, Work loss, Second law of thermodynamics for characteristic volume, Process with uniform flow, Reversible adiabatic process, Changes in entropy for ideal gases, Polytropic reversible process for ideal gases, Increase of entropy, Yield
7- **Reversibility and Availability:** Reversible work, Irreversibility, Availability

English Language for Electrical Engineers

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	31-114	English Language for Electrical Engineers	2	17	2	0	0

* Prerequisite: English II

The goal for this course is to familiarize students with scientific and technical texts in the field of Electrical Engineering. The instructor should try to use general articles in different fields of Electrical Engineering after teaching a technical English textbook.

Engineering Graphics II for Electrical Eng.

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	35-513	Engineering Graphics II for Electrical Eng.	1	17	1	2	0

* Prerequisite: Engineering Graphics

Principles of electrical drawing, Electrical components icons and legends (wires, cables, bus bar, electrical switches, lamp, distribution box, relays, motors, transformers, fuses, circuit breakers, contactors, ...), Lighting drawings (indoor and outdoor), Power distribution drawings (residential, commercial and industrial), Motor and motor control circuit drawings, Electrical drawings in accordance with the applicable codes and standards

Physics Lab II

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	24-002	Physics Lab II	1	17	0	3	0

* Prerequisite: Physics II

In accordance with the subjects taught in the Physics II (Electricity and Magnetism) course

Industrial Electronics

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-213	Industrial Electronics	3	17	3	0	1

* Prerequisite: Electronics II

1- Introduction to Industrial Electronics:
- History, Classification of electrical converters and their various industrial applications
- Analysis of electrical circuits such as RLC, LD and RLD, …

2- Solid-state switches:
- Thyristor and its internal Structure, Modeling SCR with two NPN and PNP transistors, Characteristics, Methods for turning ON and OFF, Loss, Voltage and current surges, Protection for excess current, excess voltage, Sudden changes in voltage and current (dv/dt and di/dt), Cooling, Problems in connecting thyristors in series and parallel
- Different types of thyristors: GTO, GATT, LTT, TRIAC, …
- Power transistors, Internal structure, Characteristics, Methods for turning ON, Different protection circuits, different architecture of transistors, FET, MOSFET, …

3- Control Circuits:
- Different types of circuits used in controlling electrical converters using: Diodes, Transistors, Op-Amps, CMOS, …
- Pulse generating circuits

4- Current converters in rectifier mode:
- Half-wave, full-wave, uncontrolled, half-controlled and fully controlled converters
- The effects of leakage inductance on the performance of converter (commutation overlap)
- Calculating harmonics of the networks current, Introduction to the quality coefficients for input and output of rectifiers (coefficient of transformer usage T.U.F., coefficient of total distortion T.H.D., power factor P.F., ..), Filters
- Design and selecting the components in rectifiers
- Examples of applications of rectifiers in the industry and performance of converters in different quarters
- Non-independent inverter and applications in the industry, Stability in Non-independent inverter

5- Current converters in inverter mode:
- Independent inverters (single-phase and three-phase), Different methods of controlling, Methods of harmonics reduction
- Examples of applications of independent inverters in the industry

Electrical Machines III

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-326	Electrical Machines III	4	17	4	0	1

* Prerequisite: Electrical Machines I & II

Synchronous machines:
Generated emf; output equation; armature reaction; phasor diagram; synchronous reactance; equivalent circuit; open and short-circuit characteristics; regulation; load angle; synchronous machine on infinite busbars; effects of saturation; salient-pole machine; synchronizing; synchronous motor; V curves; power factor correction.

Synchronous (Polyphase) induction motors:
Theory and construction of squirrel-cage and wound-rotor motors; equivalent circuit; measurement of equivalent circuit parameters; analysis of machine equations; speed/torque curves; circle diagram; starting performance; speed control; single-phase induction motor; deep bar effect in squirrel-cage induction motor.

Control Systems Lab

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-403	Control Systems Lab	1	17	0	3	0

* Prerequisite: Control Systems and Electrical Machines I & II

Based on the subjects taught in the Control Systems course

Nonlinear/Discrete Control Systems

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-415	Nonlinear/Discrete Control Systems	3	17	3	0	1

* Prerequisite: Control Systems

Introduction to discrete time and digital control systems, Quantization, A/D and D/A converters, Z transform, Important features and related principle, Inverse Z transform, Discrete transfer function, Solving difference equations, Sampling, Impulse sampling, Laplace transform, Reconstruction of original signal from sampled signal, Finding Z transform using convolution integral, Modified Z transform, Realization of digital controllers, Transformation between S and Z plane, Stability analysis for closed loop control systems in Z space, Bi-linear transformation, Jury stability criterion, Discrete time equivalents for continuous tom controllers, Design principles based on discrete time equivalent of a continuous time controller, Analysis of transient and steady state responses, Design of discrete time control systems using root-locus and frequency response methods, State space representation of discrete time control systems Introduction to the nonlinear behavior of systems, Analysis of phase plane and drawing the phase paths, Limit cycles, Descriptive function analysis and calculating it for regular nonlinear systems, Stable points for nonlinear systems, Concept of stability, Linearization and local stability, Lyapunov stability method

Computer Architecture and Machine Language

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-532	Computer Architecture and Machine Language	3	17	3	0	1

* Prerequisite:

Introduction to the design and analysis of the computer systems hardware, Different components of a computer system and interconnections: Control unit, Arithmetic logic unit (ALU), Input/Output and Memory, Central processor unit, Types of memory (ROM, PROM, EPROM, EEROM and RAM), Data and address registers, Data bus, Address bus, Decoders, Memory address decoding, Input/Output registers, Latch, Shift register, Programming in PDP-11 assembly language (Digital Equipment Corporation minicomputer), Programming projects

Advanced Applied Programming

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-533	Advanced Applied Programming	3	17	3	0	1

* Prerequisite: Computer Programming

Introduction to the structured programming, Pascal language: Data structures and representations, Data types, Instructions, Operators, Assignment, Loops, Conditional statements, Compiler directives, Arrays, multi-dimensional arrays, Array operations, Design and implementation of algorithms, Flow charts, Function and procedures, Parameter passing (call by value vs. call by reference), Iteration, Recursion, Pointers, linked and sequential storage allocation, linked lists, stacks, queues, trees and graphs, Records, Various techniques of sorting data, Matrix operations, Sparse matrix operations

Introduction to Linear Algebra

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	22-256	Introduction to Linear Algebra	3	17	3	0	1

* Prerequisite: General Math II

Study of Semi-group concepts, Group, Module, Loop, Field and vector space with various examples from geometry, Algebra, Real and complex functions, Linear combination and linear independence, Unit vectors, Dimensions of space, Sub-space of linear transformation (operators), Linear functional, Range, Null space, Analysis of linear transformation and functions in M dimensional space, Linear transformation on matrix, Matrix operations, Determinant, Methods for solving linear equations, Study the concept of linear algebra with various examples, Boolean algebra, Spectrum of linear transformation, Eigen values and eigen vectors, Change of unit variable and similarity transformation, Subjective matrix, Jordan forms, Kiely-Hamilton theorem, Minimal polynomial, Methods for calculating matrix functions, Linear analysis
Dual-linear and multi linear algebra, Duality, Cross product, Space with norm, Inner product, Second-degree forms

Electrical Machines Lab

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-003	Electrical Machines Lab	1	17	0	3	0

* Prerequisite: Electrical Machines I & II

In accordance with the subjects taught in the Electrical Machines I & II course.

Building Utility Design

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-314	Building Utility Design	3	17	3	0	1

* Prerequisite:

Electrical system design and drawing, cabling, lighting design and techniques indoor/outdoor residential/commercial/industrial
industrial and commercial electrical power distribution design
fundamental concepts of Electrical Design from the basic AC/DC to the single-phase and three-phase systems
design electrical circuits in accordance with the applicable codes and standards
design lighting, motor, grounding, and power distribution systems.
Wiring Method Design Applications
Premise Wiring System Design
Grounding Principles
Motor and Motor Control Design

Electrical system design and drawing, cabling, lighting design and techniques indoor/outdoor
industrial and commercial electrical power distribution design
fundamental concepts of Electrical Design from the basic AC/DC to the single-phase and three-phase systems

design lighting, motor, grounding, and power distribution systems.
Wiring Method Design Applications
Premise Wiring System Design
Principles

Wiring Regulations, Building lighting design, Building wiring code, Designs and specifies electrical power, lighting and communication systems for building
Transformer Design

Industrial Control Systems

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-419	Industrial Control Systems	3	17	3	0	1

* Prerequisite: Control Systems

Industrial processes: Linearization of nonlinear differential equation, Determining characteristics of processes using experimental methods, amplification with first-order transfer function, Processes with time delay, Causes for time delay in the process, Effects of time delay in performance of control system, Modeling of processes with one time constant and a delay, Modeling of processes with two time constants and delay

Liquid processes: Level control, Flow control, pressure control, Blender tank process and industrial examples of liquid process control

Thermal processes: Different types of thermal processes, Blending, Heat exchange, Producing electricity, Industrial examples of thermal processes

Rolling mill processes: Thickness control, Tension control

Miscellanious control systems: Plane, Ship, Guided objects, etc.

Controllers (introduction and general structure): Pneumatic controllers (P, PI, PID), Electronic controllers (PID), How controllers look, On/Off controllers

Tuning of controllers: Criteria for tuning controllers (such as ISE, IAE, ITAE and ZN), Tuning controllers for simple processes, Analysis of On/Off controllers, Direct process control using computers (DDC), Methods of acquisition data and measurements and sending commands using computers

Industrial applications: Industrial control application with examples in chemical, concrete, iron and steel industry

Modern control Systems

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-431	Modern control Systems	3	17	3	0	1

* Prerequisite: Control Systems and linear Algebra

Modeling and analysis of control systems in state space (continuous and discrete), System realization: Controllable, observable, diagonal and Jordan forms, Controllability and observability in systems, Systems stability, Relocating poles and state feedback, System state estimators, Duality in systems, Design of estimators using state feedback and state estimators, Introduction to the optimal controllers

Microprocessors Lab I

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-504	Microprocessors Lab I	1	17	0	3	0

* Prerequisite: Microprocessors I

In accordance with the subjects taught in the Microprocessors I course

Microprocessors I

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-543	Microprocessors I	3	17	3	0	1

* Prerequisite: Computer Programming and Logic & Switching Circuits

Types of Memory: ROM, PROM, EPROM, EEROM, Read-Write memory (RWM), Types of RWM: Bipolar, RAM, Static, Dynamic RAM

A/D and D/A converters and different types

Digital Arithmetic: Binary addition and subtraction in BCD, Excess3 BCD, hexadecimal numbers, Binary multiplication, Binary division, ALU (Arithmetic Logic Unit), fixed point and Floating point numbers

Microprocessors Architecture and operation: Basic analysis of microprocessor units, Different modes of microprocessor, Instruction register, Analysis of ALU in the microprocessor, Different modes of microprocessor

Study of 8085A microprocessor: Analysis of architecture and timing, memory I/C

Analysis of minimum-system of 8085A microprocessor: Data transfer and logic operations and branching, data exchange from I/O and to I/O (peripherals), data transfer inside the microprocessor, Logical operations, Discussion on flowcharts, Branch statements, Software delay

Assembly Programming: Language Assembler, Source programs, Software programming development, Assembler directives

Operational Research I

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	21-711	Operational Research I	4	17	4	0	1

* Prerequisite: Linear Algebra and computer programming

Introduction to operational research, Different types of models and mathematical models, Linear programming (modeling, graphical methods, simplex principle, Two phased and big M, duality, sensitivity analysis), Networks and transportation model and other similar models, Study of real variable programming, Introduction to dynamic programming, Introduction to non-linear programming, Introduction to probability models

General Chemistry I

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	23-011	General Chemistry I	3	17	3	0	1

* Prerequisite: None

Electronics Lab II

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-203	Electronics Lab II	1	17	0	3	0

* Prerequisite: Electronics Lab I and Electronics II

In accordance with the subjects taught in the Electronics II course

Industrial Electronics Lab

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-205	Industrial Electronics Lab	1	17	0	3	0

* Prerequisite: Industrial Electronics

In accordance with the subjects taught in the Industrial Electronics course

Filters

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-212	Filters	3	17	3	0	1

* Prerequisite:

Two-port networks and parameters. Magnitude and phase approximation. Butterworth and Chebyshev filters. Realization of high-order transfer functions. GIC and FDNR second order active RC filters. Op-amp based designs. Monolithic continuous time filter. OTA based designs. Monolithic sampled data filters. Switched capacitor filters.

Control Systems Project

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	25-450	Control Systems Project	3	N/A	N/A	N/A	N/A

* Prerequisite: Last semester

Design and implementation of a lead-screw digital position control system

Electric Workshop

Name of Institution	Course Number	Course title	Credits	Duration of Course in Number of weeks	Number of Lecture Hours per week	Number of LAB hours per week	Number of Tutorial Hours per week
Sharif University of Technology	33-014	Electric Workshop	1	17	0	3	0

* Prerequisite: General Workshop

Preventing electric shock (workplace health and safety), lightning arresters, Introduction to grounding, Introduction to different types of distribution cables and wires and the connections, Introduction to circuit breaker (sectioner), Introduction to power circuit breakers (power switches), Introduction to the capacitors and reactors, Applications of single-pole, double-pole, change-over switches and sockets, Signal transmit systems and relays, control circuits and contactors, Introduction to insulation (suspension and bus insulation and etc), Residential and commercial wiring, Design and assembly of low power and high power electric panels, Introduction to different transformers and their applications (power transformers, current transformer, voltage transformer, radio transformers).

- 25-156. Digital Signal Processing

Introduction to digital signal processing of continuous and discrete signals, discrete Fourier transform (DFT) and fast Fourier transform (FFT), signal sampling and reconstruction, Z-transform, design and analysis of digital filters, FIR and IIR filters, correlation and spectral estimation.

- 25-157. Digital Image Processing

Theory and application of digital image processing, mathematical description of discrete images, two-dimensional systems and two-dimensional Fourier transform, statistical aspects of images, systematic aspects of image perception, sampling and reconstruction, scalar and vector image quantization, linear operators, unitary transforms, image enhancement and restoration, image histogram, median filter, edge enhancement, inverse filters, image encoding.