

**Live MCQ™**

৪৯তম স্পেশাল বিসিএস (শিক্ষা) বিষয়ভিত্তিক প্রস্তুতি

# বিষয়: ইলেক্ট্রিক্যাল এন্ড ইলেক্ট্রনিক্স ইঞ্জিনিয়ারিং (৮৯২)

## Compendium PDF

(সিলেবাস অনুসারে সর্বাধিক গুরুত্বপূর্ণ টপিক ও এমসিকিউ-এর সমন্বয়ে রচিত)

**Mentor:**

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কুমিল্লা সরকারি কলেজ।

৩৮তম বিসিএস (সাধারণ শিক্ষা ক্যাডার)

### সূচীপত্র

| ক্রমক | বিষয়                                       |
|-------|---------------------------------------------|
| 1.    | পিএসসি নির্ধারিত সিলেবাস ও মানবন্টন         |
| 2.    | টপিক সমূহের গুরুত্ব নির্ধারণ                |
| 3.    | বুক লিস্ট                                   |
| 4.    | শেষ মুহূর্তের নির্দেশনা ও গুরুত্বপূর্ণ কৌশল |
| 5.    | সর্বাধিক গুরুত্বপূর্ণ ২০০ + এমসিকিউ         |

| Sr | Topic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Marks Distribution              |
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|    | <p>1. Electrical Circuits</p> <p>The Basic Electrical Circuit Elements: Response of Basic R, L, and C, Average Power and Power Factor, Phasor.</p> <p>Methods of Circuit Analysis (DC &amp; AC): Ohm's Law, Nodes, Kirchhoff's Laws, Independent versus Dependent Sources, Source Conversions, Mesh Analysis, The Supermesh, Nodal Analysis, Delta-Wye Conversion.</p> <p>Network Theorems (DC &amp; AC): Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem</p> <p>RC, RL and RLC Circuits: RC and RL High-Pass, Low-Pass Filters, Band-pass, Series and Parallel RLC Resonances.</p> <p>AC Power and Polyphase Circuits: Apparent Power, Power Factor and Complex Power, Polyphase Systems, Single-Phase Three-Wire Systems, Three-Phase Y-Y Connection, The Delta Connection Power measurement in Three-Phase Systems.</p> <p>2. Electrical Machines and Transformers</p> <p>Introduction: Leakage Flux, Faraday's Laws of Electromagnetic Induction, Induced EMF, Self and Mutual Inductance, AC Excitation in Magnetic Circuit, Eddy Current Loss.</p> | <p>Part- I</p> <p>Marks: 50</p> |

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|  | <p>DC Generator: Basic Construction, Simple Loop Generator, Commutator, Armature Coils, Brushes, Armature Winding, Characteristics of Lap and Wave Winding, EMF and Torque Equation, Armature Reaction, Methods of Commutation, Types of DC Generators, No-load and Load Characteristics of Shunt, Series and Compound Generators, Losses and Efficiency of DC Generators.</p> <p>DC Motors: Working Principle of DC Motors, Back EMF and EM Torque, Series and Shunt DC Motors, Starting of Shunt and Compound Wound DC Motors, Speed Control of DC Motors, Electrical Braking of DC Motor, Losses in DC Motor, Efficiency of DC Motor.</p> <p>Synchronous Generators: General Aspects and Principles of Synchronous Machines, Generator and Motor Action, Alternating EMF, Relation between Frequency, Speed and Number of Poles, Constructional Features of Synchronous Machines, Equivalent Circuit and Phasor Diagram, Voltage Regulation, Losses and Efficiencies in Synchronous Generators, Parallel Operation of Alternators, Synchronising Single and Three Phase Alternators and Synchronising Current, Power and Torque.</p> <p>Synchronous Motors: Construction, Working Principle and Equivalent Circuit of a Synchronous Motor, Phasor Diagram, Relation between Supply and Excitation Voltage, Torques in a Synchronous Motor, Power Flow in Synchronous Motor, Effect of Load and Excitation Change,</p> <p>Three-Phase Induction Motors: Constructional and Operational Principle, Slip, Speed of Rotor Field, Rotor EMF, Resistance, Reactance, Impedance, Current and Power Factor, Rotor Equivalent Circuit, Stator Parameters, Induction Motor on No-load and on Load, Constant and Variable Losses, Power Flow, Rotor Efficiency, Torque Development, Effect of Load and Voltage on Torque, Torque-Slip Curve, Stator Resistance, Voltage-Ratio Test, No-load Test, Blocked Rotor Test.</p> <p>Starting and Speed Control Methods: Squirrel Cage Induction Motors, Slip-Ring Induction Motors, Starting Methods of Squirrel Cage Induction Motors, Speed Control by Changing the Slip, Rotor Circuit Resistance, Supply Voltage, Voltage in the Rotor Circuit, Supply Frequency, Changing the Poles, and Rotor EMF Injection.</p> |  |
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|  | <p>Single-Phase Induction Motor: Classification of Single-Phase Motors, Single Phase Induction Motors, Torque and Field in Single-Phase Induction Motors, Equivalent Circuit, Methods of Self-Starting.</p> <p>Stepper Motors: Permanent Magnet and Variable Reluctance Type.</p> <p>Transformers (single phase): Working Principle of a Transformer, Core Material and Construction, Transformer Winding, EMF Equation, An Ideal Transformer, Transformer on No-load and Load, Transformer Winding Resistance, Mutual and Leakage Fluxes, Equivalent Reactance, Equivalent Circuit for an Actual Transformer, Voltage Regulation, Losses in a Transformer, Efficiency of a Transformer, Transformer Tests: Open-circuit or No-load Test, Short Circuit Test, Auto-transformer.</p> <p>Transformers (three phase): Merits and Construction of Three Phase Transformer, Relative Primary and Secondary Windings, Polarity of Transformer Windings, Phasor Representation, Three-Phase Transformer Connections, Selection of Transformer Connections: Star-Star, Delta-Delta, Star-Delta Connections, Delta-Star and Delta-Zigzag, Parallel Operation of Three-Phase Transformers, Open-Delta or V-V and T-T Connections</p> <p><b>3. Power System</b></p> <p>Overview of Modern Power Systems: Generations, Transmissions and Distributions.</p> <p>Representation of Power Systems: Single-Line Diagram, Per-Unit Methodology. Modelling Circuit of Power System Components: Transformers, Generators, Loads, Current-Voltage Relationships on Transmission Line: Representation of Lines, Short Transmission Line, Medium-Length Line, Long Transmission Line, Power Flow through a Transmission Line.</p> <p>Power System Fault Calculations: Symmetrical Components, Symmetrical Faults: Transients in RL Series Circuits, Internal Voltages of Loaded Machines,</p> <p>Under Fault Conditions, Fault Calculations using Z-Bus,</p> <p>Unsymmetrical Faults: Unsymmetrical Faults on Power System, Single Line-to-Ground Faults, Double Line-to- Ground Faults, Open-Conductor Faults.</p> |  |
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|  | <p>Power Transmission/Distribution Paths: Overhead Transmission Lines, Underground/Underwater Cables, and their Mechanical Designs.</p> <p>Power System Stability: Overview on Steady-State and Dynamic Behaviour of Power Systems, Classification of Stability, Rotor Angle Stability- Swing Equation, Power Angle Equation, Equal Area Criterion, Multi-Machine System, Factors Affecting Stability.</p> <p>Flexible AC Transmission System (FACTS): Introduction, SVC, STATCOM, SSSC, TCSC, TCSR, TCPST, UPFC, IPFC, DVR.</p> <p>High Voltage DC (HVDC) Transmission System: Types of HVDC, Its Components and Operations.</p> <p>Switch Gear and Protection:</p> <p>Circuit Breakers: Significance of switchgear and protection in power system, Principle of arc extinction in DC and AC circuit breakers, Re-striking voltage, Recovery voltage, Rate of rise of recovery voltage, Resistance switching, Current chopping and interruption of capacitive current, Types, construction and operating mechanisms of air circuit breaker (ACB), Oil circuit breaker (OCB), Vacuum circuit breaker (VCB) and sulfur hexafluoride (SF<sub>6</sub>) circuit breaker, Rating and selection of power circuit breakers, Testing of high voltage circuit breakers.</p> <p>Protective Relays: General requirements, Relay operation principles, Construction of relays, Relay currents and voltages, Use of instrument transformer for relays, Problem of</p> <p>high speed relaying transmission lines, Operating characteristics of different types of relays: DMT and IDMT relays, Overcurrent relay, Directional relay, Differential relay, Impedance relay, Reactance relay, Mho relay, Modified impedance relay, Zero sequence and negative sequence relays, Balance current relaying of parallel line, Ground fault relaying, Pilot relaying principles, Carrier pilot relay, Apparatus protection, Circuits and relay setting, Generator and motor protection, Transformer protection, Busbar protection, Line protection, HVDC system protection.</p> |  |
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|  | <p><b>4.Power Plant Engineering</b></p> <p>Thermal, Steam, Hydroelectric barge mounted, Nuclear power plant load curves, Estimates of load, Load curves, Study and analysis of load curves, Interpretation of load curves, Determination of actual demand and capacity of various components in a system, Plotting the expected load curve of a system, Use of the load curves, Load growth and extrapolation of load curves, Selection of plant, Effect of variable load on power plant design, Continuity of service requirements and its effect on plant design, Cost consideration, Equations of performance for plant equipment and electric service, Selection of units, Standby units, Large and small units, Number and sizes of units, Plant location, Considerations for site selection for different types of plants, General considerations for different types of power plants: large, medium and small, conventional and nuclear. Introduction to Non- conventional Renewable Energy Conversion: Solar, Wind and wave electric energy converters.</p> <p>Renewable Energy: Wind turbine generators, Construction &amp; basic characteristics of solar cells, Photovoltaic systems, Fuel cells, Hybrid systems, Tidal energy, Biogas &amp; biomass energy. Economic marginal transmission cost, Graphical solution for location of different types of distribution, Rectangular distribution of loads, Economic conductor selection and general consideration, The ideal conductor, Effect of any deviation from the ideal cross- section, Limits for size of underground cables, Selection of ideal supply voltage, Plant performance and operation characteristics, Performance characteristics, Efficiency, Heat rate, Incremental rate method, Station performance characteristics, Station incremental rate, Capacity scheduling, Base load and peak load, Load division between steam and hydro stations, Bus system, Importance of power control, Current limiting reactors, Different types of bus system layouts, Forces on buses in the case of short circuits, Nuclear power stations, Comparison with conventional generation methods, Chain reactions, Moderators, Classification of reactors, Special power reactors, Shielding.</p> |  |
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| 2 | <p>1. Electronics, Power Electronics Analog Electronics:<br/>PN Junction Diode and Diode Circuits: Semiconductor Materials, Construction<br/>of PN Junction, Formation of Depletion Layer and Barrier Voltage in PN Junction, I-V Characteristics of a PN Junction Diode, Load Line, Half -Wave and Full-Wave Rectifier, Voltage Multiplier, Clipper and Clamper, Zener Diode Operation and Applications.<br/>Bipolar Junction Transistors (BJT): Construction and Operation of BJT, Amplifying Action, Characteristics of BJT in CB and CE configurations, Current gain- <math>\alpha</math> and <math>\beta</math>, Q-Point and Load Line, Different Biasing Circuits, Stability Factor, BJT as a Switch, re and Hybrid (h-Parameter) Equivalent Circuit of BJT.<br/>Single Stage BJT Amplifier Circuits: Operation of Single-Stage Amplifier, Voltage and Current Gain, Input and Output Impedance of CB, CE, CC Configurations using h- Parameter.<br/>Field Effect Transistor (FET): JFET Structure, Operation and Characteristics, h- Parameters for JFET, MOSFET Construction, Operation and Characteristics, Biasing Circuits of JFET and MOSFET, Single-stage JFET Amplifier, MOSFET as a Switch, CMOS Inverter.<br/>Feedback Amplifiers: Principle of Feedback Amplifier, Positive and Negative Feedback, Advantages of Negative Feedback, Gain Stability.<br/>Operational Amplifiers (Op-Amp):<br/>Basic Construction of Op-Amp, Properties of Ideal Op-Amps, Frequency Response of Op- Amps, Inverting and Non-Inverting Amplifier, Summing and Difference Amplifier, Voltage Follower, Differentiator, Integrator, Op-Amp Comparator, Precision Rectifier, Active Filters- Different Types of Filters, Transfer Functions, Design and Construction of First and Second Order Low, High and Band Pass Filters using Op-Amps.<br/>Oscillators: Basic Principle of Oscillator, Bark-Hausen Criterion, Phase Shift Oscillators, Wein Bridge Oscillator, Colpitts and Hartley, Crystal Oscillator, Negative Resistance Oscillator.<br/>Power Amplifiers: Class A, Class B, Class AB Power Amplifier, Transformer-Coupled Class A Amplifier, Push-Pull Amplifier, Complementary Symmetry, Quasi- Complementary, Class-D Amplifier.</p> | <p>Part- II</p> <p>Marks: 50</p> |
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|  | <p>Pulse and Switching Circuits: Classification of Multivibrators (MV), Astable, Monostable MV using BJT, Schmitt Trigger with BJT, Voltage and Time Base Generators.</p> <p>Voltage Regulators: Series and Shunt Regulations, Design of voltage regulators.</p> <p>Phase Locked Loops (PLL): Basic PLL, Major Building Blocks, Lock and Capture Range, Applications of PLL, FM Demodulation, FSK Demodulation, AM Demodulation, Frequency Synthesizer.</p> <p>Digital Electronics:</p> <p>Logic Gates: Different types of logic gates, Universal Gates.</p> <p>Boolean Algebra and Logic Simplification: Boolean Operations, De Morgan's Theorems, Boolean Analysis of Logic Circuits, Karnaugh Map, Don't Care Conditions.</p> <p>Arithmetic Operations and Circuits: Half and Full Adders, Half and Full Subtractor, 2's complement, Ripple Carry and Look-Ahead Carry Adders, BCD Adders, Cascading BCD Adders,</p> <p>Functions of Combinational Logic: Binary-to-Decimal Decoders, BCD-to-Decimal Decoder, BCD-to-7-Segment Decoder/Drivers, Decoder IC, Encoders and Applications.</p> <p>Multiplexers: Two, Four, Eight, Sixteen input multiplexers, Quad Two-Input MUX, Multiplexer Applications.</p> <p>Sequential Logic: NAND/NOR Gate Latch, Edge-Detector Circuit, Clocked S-C, J-K, D and T Flip-Flops, Master/Slave Flip-Flop, Clocked J-K Flip-Flop with Asynchronous Inputs, Flip Flop Applications: Switch Bouncing Reduction, Parallel Data Transfer, Serial Data Transfer.</p> <p>Shift Registers and Counters: Types of Shift Register, Operatoin, Shift Register Counters: Ring Counter and Johnson Counter, Asynchronous Counters, Asynchronous Down Counters, Synchronous Up/Down Counters, Pre-settable Counters, Design of Synchronous Counters and Cascaded Counters.</p> <p>Digital-to-Analog Conversion and Analog-to-Digital Conversion: Weighted Resistors, R-2R Ladder DAC, Methods of ADC: Flash, Digital Ramp, Successive Approximation Converter, ADC and DAC Applications.</p> |  |
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|  | <p>Digital MOSFET Circuits: NMOS, PMOS and CMOS logic circuits. Programmable Logic Device: Programmable Logic Device (PLD), Programmable Logic Array (PLA), Field-Programmable Gate Array (FPGA).</p> <p>Power Electronics:</p> <p>Power Semiconductor Switches and Triggering Devices: BJT, MOSFET, SCR, IGBT, GTO, TRIAC, UJT and DIAC.</p> <p>Rectifiers: Uncontrolled and Controlled Single Phase and Three Phase Rectifiers. Regulated Power Suppliers: Linear-Series and Shunt, Buck, Boost, Buck-Boost and Cuk Regulators. AC Voltage Controllers, Single and Three-Phase, Choppers, DC Motor Control. Inverters: Single Phase and Three Phase Current and Voltage Source, Resonance Inverters, Pulse Width Modulation Control of Static Converters.</p> <p>AC Motor Control, Stepper Motor Control.</p> <p>2. Communication Engineering</p> <p>Overview of Communication Systems: Basic Principles, Fundamental Elements, System Limitations, Message Source, Bandwidth Requirements, Transmission Media Types, Bandwidth and Transmission Capacity.</p> <p>Noise: Sources of Noise, Characteristics of Various Types of Noise and Signal to Noise Ratio.</p> <p>Analog Communication Systems: Amplitude Modulation- Introduction, Double Side Band, Single Side Band, Vestigial Side Band, Quadrature, Spectral Analysis of Each Type, Envelope and Synchronous Detection, Angle Modulation-Instantaneous Frequency, Frequency Modulation (FM) and Phase Modulation (PM), Spectral Analysis, Demodulation of FM and PM, AM Transmitter and Receiver, FM Transmitters and Receivers, Noise Limiting Circuits, AGC Circuits, Sampling Theorem, Nyquist Criterion, Aliasing, Instantaneous and Natural Sampling, Flat-Topped Sampling, Pulse Amplitude Modulation- Principle, Bandwidth Requirements, Pulse Code Modulation (PCM)- Quantization Principle, Quantization Noise, Nonuniform Quantization, Signal to Quantization Noise Ratio, Differential PCM, Demodulation of PCM, Delta Modulation (DM)-</p> |  |
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|  | <p>Principle, Adaptive DM, Delta-Sigma Modulation, Adaptive DPCM (ADPCM), Line Coding- Formats and Bandwidths.</p> <p>Digital Modulation and Demodulation: Amplitude-Shift Keying- Principle, ON-OFF Keying, Bandwidth Requirements, Detection, Noise Performance, Phase-Shift Keying (PSK)- Principle, Bandwidth Requirements, Detection, Differential PSK, Quadrature PSK,</p> <p>Noise Performance, Frequency-Shift Keying (FSK)- Principle, Continuous and Discontinuous Phase FSK, Minimum-Shift Keying (MSK), GMSK, Bandwidth Requirements, Detection of FSK, Multilevel Signalling, M-Ary Modulation Techniques, Spread Spectrum Modulation Techniques, DSSS, FHSS.</p> <p>Multiplexing: Time-Division Multiplexing (TDM), Receiver Synchronization, Frame Synchronization, TDM of Multiple Bit Rate Systems, Frequency-Division Multiplexing (FDM) Principle, Demultiplexing; Wavelength-Division Multiplexing, Multiple-Access Network- Time-Division Multiple-Access (TDMA), Frequency-Division Multiple Access (FDMA), Code-Division Multiple-Access (CDMA) Spread Spectrum Multiplexing, Coding Techniques and Constraints of CDMA.</p> <p>3. Microprocessor and Interfacing</p> <p>Introduction to Microprocessor: Classification and Evolution of Microprocessor, Difference between Microprocessor and Microcontroller.</p> <p>8086 Microprocessor: Basic Architecture, Registers, Flags, Real Mode Operation of 8086 Microprocessor, Segment, Offset and Physical Address, Instruction Format, Functions of Different Instructions of 8086 Microprocessor, Pins and Signals, Bus Buffering and Latching, Bus Timing, Ready and Wait State Generation, Clock Generator (8284A), Memory Segmentation.</p> <p>Interrupts: Introduction to Interrupts, Interrupt Vector Table, Interrupt Instructions and Operation, Hardware and Software Interrupts, Interrupt Driven I/O, Programmable Interrupt Controller (8259A).</p> |  |
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|  | <p>Microprocessor Programming: Introduction to Assembly Language Programming (ALP), Macro and Procedure, Writing Simple ALPs using Different I/O Functions, Macro, Procedures.</p> <p>Memory: Memory Types, Memory Banks, Memory Read-Write Cycle, Memory Interfacing.</p> <p>I/O Interfacing: I/O Instructions, Basic I/O Interfacing, I/O Port Address Decoding, Programmable Peripheral Interface (8255A IC), Peripheral Interfacing Examples, Programmable Interval Timer (8254), Timer Interfacing, D/A and A/D Converter, Programmable Communication Interface, Interfacing Serial I/O Devices.</p> <p>DMA: Basic DMA Operation, DMA Controller, DMA Processed Interface.</p> <p>4. Control Systems</p> <p>Introduction: Introduction to Control Systems, Definitions and classification</p> <p>Solution of Differential Equations: Standard Inputs to Control Systems, SteadyState Response and Transient Response.</p> <p>System Representation: Block Diagrams, Determination of the Overall Transfer Function, Signal Flow Graphs.</p> <p>Control System Characteristics: Routh-Hurwitz Stability Criterion, Feedback System Types, Analysis of System, Types, Steady-Mate Error Coefficients, Non Unity-Feedback System.</p> <p>Root Locus: Plotting Roots of a Characteristics Equation, Qualitative Analysis of the Root Locus, Open-Loop Transfer Function, Poles of the Control Ratio, Applications of the Magnitude and Angle Condition.</p> <p>Root Locus Compensation Design: Introduction to Design, Transient Response Dominant Complex Poles, Additional Significant Poles, Ideal Integral Cascade Compensation (PI Controller), PID controller, Ideal Derivative Cascade Compensation (FD Controller), FID Controller, Introduction to Feedback Compensation.</p> |  |
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Whole syllabus is analysed and divided between Most important topic and important topic. You may skip “important topic”

| Topic                               | Most Important Topics                                                                                                                                                                                                          | Important Topics                                                                                                                                         |
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| 1. Electrical Circuits              | Ohm's Law, Kirchhoff's Laws, Mesh & Nodal Analysis, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer, RLC Resonance, RC & RL Filters, Power Factor, Phasor Concepts                         | Delta-Wye Conversion, Source Conversions, Supermesh Analysis, Apparent/Complex Power, Three-Phase Y & $\Delta$ Connections, Power Measurement in 3-Phase |
| 2. Electrical Machines – DC         | DC Generator: EMF Equation, Types (Shunt, Series, Compound), Characteristics, Armature Reaction, Commutation; DC Motor: Working Principle, Back EMF, Torque Equation, Speed Control, Losses & Efficiency                       | Lap vs Wave Winding, Electrical Braking, Starting of DC Motors, Types of Commutation                                                                     |
| 3. Synchronous Machines             | Frequency-Poles-Speed Relation, EMF Equation, Equivalent Circuit & Phasor Diagram, Voltage Regulation, Parallel Operation of Alternators, Synchronization Conditions, Torque & Power Flow in Synchronous Motor                 | Constructional Features, Effect of Load & Excitation Change, Losses & Efficiency                                                                         |
| 4. Induction Motors                 | Construction, Slip, Torque-Slip Curve, Equivalent Circuit, Starting Methods (Squirrel Cage & Slip-Ring), Speed Control Methods, Tests (No-load, Blocked Rotor)                                                                 | Power Flow Diagram, Effect of Voltage on Torque, Constant & Variable Losses                                                                              |
| 5. Transformers (1-Phase & 3-Phase) | EMF Equation, Equivalent Circuit, Voltage Regulation, Efficiency, OC & SC Tests, Auto-transformer, Transformer Connections (Star-Star, Delta-Delta, Star-Delta, Delta-Star), Parallel Operation                                | Core Materials, Leakage Flux, Polarity, Open-Delta (V-V), Delta-Zigzag                                                                                   |
| 6. Power System – Basics            | Single Line Diagram, Per-Unit System, Transmission Line Parameters (Short, Medium, Long), Symmetrical & Unsymmetrical Faults, Symmetrical Components, Power Angle Equation, Equal Area Criterion                               | Z-Bus Fault Calculation, Overhead vs Underground Cables, Load Flow Concepts                                                                              |
| 7. Power System – Protection        | Circuit Breakers: Principle of Arc Extinction, Types (ACB, OCB, VCB, SF <sub>6</sub> ), Recovery Voltage; Protective Relays: Overcurrent, Differential, Impedance, Mho Relay, IDMT Relay, Generator/Transformer/Bus Protection | Carrier Pilot Relay, Zero Sequence & Negative Sequence Relays, Line Protection                                                                           |
| 8. Power Plant Engineering          | Load Curves, Base Load vs Peak Load, Plant Location Factors, Performance Characteristics (Efficiency, Heat Rate), Nuclear Power Basics (Chain Reaction, Moderators, Reactors)                                                  | Standby Units, Bus System Layouts, Current Limiting Reactors, Site Selection Criteria                                                                    |

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| 9. Renewable & Modern Systems | Solar Cell Basics, Wind Turbine Principle, Fuel Cells, Tidal & Biomass Energy, HVDC Transmission (Types & Components), FACTS Devices (SVC, STATCOM, TCSC, UPFC)                                                                                                                                                                                                                                                                                       | Hybrid Systems, Biogas Energy, Economic Conductor Selection, Smart Grid Concepts                                                       |
| Topic                         | Most Important Topics (High Probability in BCS MCQ)                                                                                                                                                                                                                                                                                                                                                                                                   | Important Topics (Moderate Probability)                                                                                                |
| Analog Electronics            | PN Junction: barrier potential, I-V characteristics, rectifiers (efficiency, ripple), Zener diode (voltage regulator) BJT: CE, CB configuration, current gain $\beta$ , biasing basics, amplifier action MOSFET basics & CMOS inverter Op-Amp: ideal properties, inverting/non-inverting, integrator/differentiator, filters Oscillators: Barkhausen, Wein Bridge, Colpitts, Hartley, Crystal Power Amplifiers: Class A, B, AB, push-pull, efficiency | Clippers & clampers Hybrid parameters JFET operation Feedback amplifiers (advantages) Multivibrators, Schmitt Trigger PLL applications |
| Power Electronics             | Power semiconductor devices: SCR, TRIAC, IGBT, MOSFET, UJT Rectifiers: half-wave, full-wave, controlled vs uncontrolled Converters: Buck, Boost, Buck-Boost basics Class A vs Class B efficiency                                                                                                                                                                                                                                                      | Choppers AC voltage controller basics Resonant inverters Motor control concepts                                                        |
| Digital Electronics           | Logic gates & universal gates (NAND, NOR) Boolean algebra, De Morgan's law, K-map simplification Flip-flops: SR, JK, D, T (truth tables) Counters: ripple, synchronous, Johnson, ring ADC/DAC: R-2R ladder, Flash ADC, SAR ADC                                                                                                                                                                                                                        | Multiplexers & decoders Half & full adders BCD adder Shift registers FPGA/PLA basics                                                   |
| Communication Engineering     | AM/FM/PM basics, bandwidth, demodulation methods Sampling theorem, Nyquist rate, aliasing PCM, Delta modulation, DPCM, ADPCM Digital modulation: ASK, FSK, PSK, QPSK, MSK (comparisons, noise immunity, bandwidth) Multiplexing: TDM, FDM, CDMA, WDM                                                                                                                                                                                                  | Noise sources & SNR Vestigial Sideband (VSB) AGC circuits Line coding basics Spread spectrum (DSSS, FHSS)                              |
| Microprocessor (8086)         | Microprocessor vs microcontroller 8086 architecture: registers, flags, segment+offset = physical address Instruction format & addressing modes Interrupts: hardware vs software, 8259 basics                                                                                                                                                                                                                                                          | 8255 PPI basics 8254 timer DMA controller (basic function) Assembly language simple instructions                                       |
| Control Systems               | Routh-Hurwitz stability criterion Block diagram reduction & transfer function Root locus basics (conditions, interpretation) Steady-state error constants (position, velocity, acceleration) PID controller basics                                                                                                                                                                                                                                    | Signal flow graph basics Compensation design (PI, PD, PID) Standard input responses (step, ramp, impulse)                              |

### Reference books

| 1.  | Book Name                                              | Author                            |
|-----|--------------------------------------------------------|-----------------------------------|
| 2.  | Introductory Circuit Analysis                          | Robert L. Boylestad               |
| 3.  | Principles of Electrical Machines                      | VK Mehta                          |
| 4.  | <b>Elements of Power System Analysis</b>               | William D. Stevenson              |
| 5.  | Power System Protection                                | Paul M. Anderson                  |
| 6.  | Switchgear And Protection                              | J. B. Gupta                       |
| 7.  | Power Plant Engineering                                | P. K. Nag                         |
| 8.  | Electronic Devices and Circuit Theory                  | Robert Boylestad                  |
| 9.  | Op-Amp                                                 | ramakant gayakwad                 |
| 10. | Power Electronics: Devices, Circuits and Applications  | Muhammad H. Rashid                |
| 11. | Communication Systems                                  | Michael Moher and Simon S. Haykin |
| 12. | Microprocessor                                         | Ramesh S. Gaonkar                 |
| 13. | Control Systems Engineering / Automatic Control System | Norman Nise / Benjamin Kuo        |

### Last Moment Prep and Strategy

#### Study & Preparation Strategy

1. **Understand the Syllabus Thoroughly** – Know which subjects/topics are given more weight.
2. **Break Down Topics** – Study in small portions (e.g., one law, one formula, one definition per sitting).
3. **Make Short Notes / Flashcards** – Keep one-liner key points for last-minute revision.
4. Go through the provided pdf
5. Go through the compendium
6. Must revise what you have studied
7. Practice at least one job solution question per day
8. Focus on Previous Year Questions – Analyze trends to identify recurring topics.
9. Use Elimination Method – When unsure, remove wrong choices first, then guess from the remaining.

#### Practice & Revision Strategy

1. **Timed Practice** – Solve mock tests within time limits to simulate the real exam.

2. **Error Log Book** – Maintain a notebook of wrong answers with explanations, revise weekly.
3. **Group Discussion** – Sometimes explaining a topic to peers helps with retention.
4. **Weekly Revision Cycle** – Whatever is studied during the week must be revised on weekends.

### Exam Hall Strategy

11. **Read Carefully** – Avoid silly mistakes by reading every word in the question.
12. **Don't Get Stuck** – If one question takes too long, move on and come back later.
13. **Answer What You Know First** – Build confidence and save time.
14. **Smart Guessing** – If negative marking is not heavy, make an educated guess.
15. **Time Allocation** – Divide time per section and stick to it.

### Topic-Wise Brief Discussion

#### 1. Ohm's Law

- Formula:  $V = IR$
- $R = \frac{V}{I}$ ,  $I = \frac{V}{R}$
- Resistance  $\propto$  length (L), inversely  $\propto$  area (A).
- Unit: Ohm ( $\Omega$ ).

#### 2. Kirchhoff's Laws

- **KCL (Current Law):** Algebraic sum of currents at a node = 0.  
 $\Rightarrow \sum I_{in} = \sum I_{out}$
- **KVL (Voltage Law):** Algebraic sum of voltages around a closed loop = 0.  
 $\Rightarrow \sum V = 0$

### 3. Mesh & Nodal Analysis

- Mesh (loop current method): Apply KVL in loops. Unknowns = loop currents.
- Nodal (node voltage method): Apply KCL at nodes. Unknowns = node voltages.

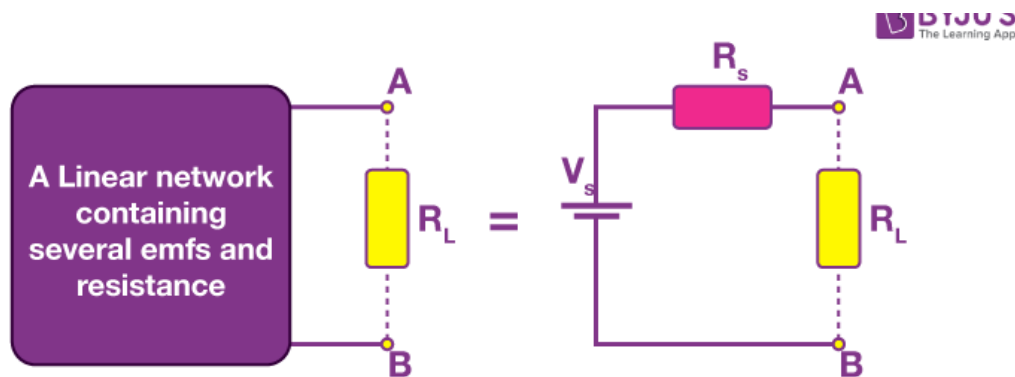
### 4. Superposition Theorem

- In a linear circuit with multiple sources, total response = algebraic sum of responses due to each source acting alone.
- Steps: Turn on one source → turn off others (replace V-source with short, I-source with open).



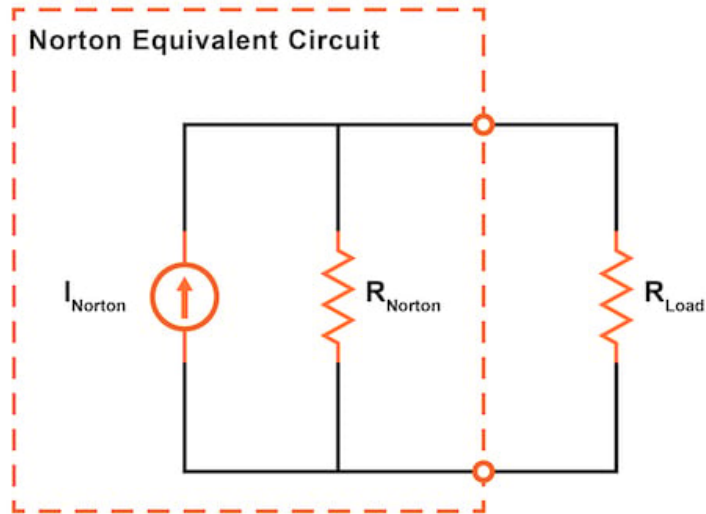
### 5. Thevenin's Theorem

- Any linear two-terminal network → equivalent to **one voltage source ( $V_{th}$ ) in series with one resistance ( $R_{th}$ )**.
- $V_{th}$  = open circuit voltage.
- $R_{th}$  = equivalent resistance when independent sources are killed.



## 6. Norton's Theorem

- Any linear two-terminal network  $\rightarrow$  equivalent to **one current source ( $I_N$ ) in parallel with one resistance ( $R_N$ )**.
- $I_N$  = short-circuit current.
- $R_N = R_{th}$ .



## 7. Maximum Power Transfer Theorem

- Maximum power to load when:
  - $R_L = R_{th}$  (DC)
  - $Z_L = Z_{th}^*$  (AC, conjugate matching).
- Max power =  $\frac{V_{th}^2}{4R_{th}}$ .

## 8. RLC Resonance

- Series resonance:  $X_L = X_C$ .
- Resonant frequency:

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

- Impedance = R (minimum). Current = maximum.
- Quality factor:  $Q = \frac{1}{R} \sqrt{\frac{L}{C}}$ .

## 9. RC & RL Filters

- RC Filter (Low-pass): Passes low frequency, attenuates high.
- RL Filter (High-pass): Passes high frequency, attenuates low.
- Cutoff frequency:  $f_c = \frac{1}{2\pi RC}$  or  $f_c = \frac{R}{2\pi L}$ .

## 10. Power Factor

- P.F. =  $\cos \phi = \frac{\text{Real Power}}{\text{Apparent Power}} = \frac{P}{S}$ .
- Lagging PF → Inductive load.
- Leading PF → Capacitive load.
- Unity PF → Purely resistive.

Most economical pf = .95 lagging

### Tips for MCQ Prep (BCS):

- Always remember **formulas + definitions**.
- Focus on **resonant frequency, Thevenin/Norton, KCL/KVL**—very common in MCQs.
- Memorize **cutoff frequencies & power factor relations**.

**1. Resistance of a wire is doubled if:**

- A) Length is doubled, area constant ✓
- B) Length halved, area constant
- C) Area doubled, length constant
- D) Temperature reduced

**Answer:** A) Length is doubled, area constant

**2. Mesh analysis is best applied in:**

- A) Circuits with more nodes
- B) Circuits with more loops ✓
- C) Digital circuits
- D) Magnetic circuits

**Answer:** B) Circuits with more loops

**3. Nodal analysis primarily calculates:**

- A) Loop currents
- B) Node voltages ✓
- C) Impedance
- D) Admittance

**Answer:** B) Node voltages

**4. Superposition theorem can be applied to:**

- A) Power calculation
- B) Linear circuits with multiple sources ✓
- C) Non-linear circuits
- D) Magnetic circuits

**5. Answer:** B) Linear circuits with multiple sources

**While applying superposition, voltage source is replaced by:**

- A) Open circuit
- B) Short circuit ✓
- C) Resistance
- D) Nothing

**Answer:** B) Short circuit

**6. Thevenin equivalent resistance is found by:**

- A) Removing load & finding open circuit voltage
- B) Killing sources & finding equivalent resistance ✓
- C) Measuring short-circuit current
- D) Using nodal analysis only

**Answer:** B) Killing sources & finding equivalent resistance

**7. In Thevenin's theorem,  $V_{th}$  is:**

- A) Short-circuit current
- B) Open-circuit voltage ✓
- C) Maximum power transfer
- D) Equivalent resistance

**Answer:** B) Open-circuit voltage

**8. Norton's current ( $I_n$ ) is equal to:**

- A) Open-circuit voltage / load resistance
- B) Short-circuit current at load terminals ✓
- C) Maximum power transfer current
- D) RMS value of voltage

**Answer:** B) Short-circuit current at load terminals

**9. Norton resistance ( $R_n$ ) is equal to:**

- A) Thevenin resistance ✓
- B) Open-circuit voltage
- C) Load resistance
- D) Short-circuit current

**Answer:** A) Thevenin resistance

**10. Maximum power is delivered to the load when:**

- A) Load resistance is zero

- B) Load resistance is infinite  
C) Load resistance = source resistance ✓  
D) Load current = source current

Answer: C) Load resistance = source resistance

**11. Maximum power transfer efficiency in DC circuits is:**

- A) 25%      B) 50% ✓  
C) 75%      D) 100%

Answer: B) 50%

Resonance occurs when:

- a.  $X_c = X_L$   
b.  $X_c > X_L$   
c.  $X_c < X_L$   
d. None

$X_c = X_L$

**16. Resonant frequency of LC circuit:**

- A)  $f_r = \frac{1}{2\pi\sqrt{LC}}$  ✓  
B)  $f_r = 2\pi\sqrt{LC}$   
C)  $f_r = \frac{1}{\pi\sqrt{LC}}$   
D) None

Answer: A)  $f_r = \frac{1}{2\pi\sqrt{LC}}$

**17. At resonance, power factor of series RLC circuit is:**

- A) 0      B)  $\infty$   
C) 1 ✓      D) Cannot be determined

Answer: C) 1

**19. Cutoff frequency of an RC filter:**

- A)  $f_c = \frac{1}{2\pi RC}$  ✓  
B)  $f_c = \frac{R}{2\pi L}$   
C)  $f_c = \frac{1}{LC}$   
D)  $f_c = \frac{1}{2\pi L}$

Answer: A)  $f_c = \frac{1}{2\pi RC}$

**20. An RL circuit works as:**

- A) Low-pass filter      B) High-pass filter ✓  
C) Band-pass filter      D) Band-stop filter

Answer: B) High-pass filter

Power Factor

**21. Power factor is defined as:**

- A) Ratio of apparent power to real power  
B) Ratio of real power to apparent power ✓  
C) Ratio of reactive power to real power  
D) Product of voltage and current

Answer: B) Ratio of real power to apparent power

**22. A lagging power factor indicates:**

- A) Capacitive load      B) Inductive load ✓  
C) Resistive load      D) Open circuit

Answer: B) Inductive load

**23. Unity power factor occurs in:**

- A) Pure inductance      B) Pure capacitance  
C) Pure resistance ✓      D) RLC resonance only

Answer: C) Pure resistance

**24. A phasor diagram is used to represent:**

- A) DC waveforms  
B) AC sinusoidal waveforms ✓  
C) Non-sinusoidal signals  
D) Digital signals

Answer: B) AC sinusoidal waveforms

**25. In a purely inductive circuit, current lags voltage by:**

- A)  $0^\circ$       B)  $90^\circ$  ✓  
C)  $180^\circ$       D)  $270^\circ$

Answer: B)  $90^\circ$

## DC Generator:

### 1. EMF Equation

- Induced EMF per conductor:

$$e = \frac{d\phi}{dt}$$

- Average EMF:

$$E = \frac{P\Phi ZN}{60A}$$

where:

- $P$  = number of poles
- $\Phi$  = flux per pole (Wb)
- $Z$  = total armature conductors
- $N$  = speed in rpm
- $A$  = number of parallel paths



## Commutation

- Process of current reversal in armature conductors through brushes.
- Poor commutation  $\rightarrow$  sparking.
- Improved by using:
  - Interpoles (commutating poles).
  - Brush shift.
  - High resistance brushes

## 2. Back EMF

- As motor rotates, conductors cut flux → induce EMF opposite to supply.
- Expression:

$$E_b = \frac{P\Phi ZN}{60A}$$

- Significance: Regulates motor speed & protects motor from damage.

## 3. Torque Equation

- Torque (T):

$$T = \frac{PZ}{2\pi A} \Phi I_a$$

- Hence,  $T \propto \Phi I_a$ .

## 6. Efficiency

- Efficiency:

$$\eta = \frac{\text{Output}}{\text{Input}} \times 100$$

- **Condition for maximum efficiency:**

Copper loss = Constant loss

**1. In a shunt generator, the field winding is connected:**

- A) In series with armature
- B) In parallel with armature ☒
- C) Across brushes only
- D) None

Answer: B) In parallel with armature

**2. In a series generator, voltage drops sharply with load due to:**

- A) Armature resistance
- B) Armature reaction ☒
- C) Brush contact resistance
- D) Constant flux

Answer: B) Armature reaction

**3. In a compound generator, series field is used to:**

- A) Reduce losses
- B) Compensate voltage drop ☒
- C) Increase efficiency
- D) Increase commutation

Answer: B) Compensate voltage drop

**5. Armature reaction mainly causes:**

- A) Increase in speed
- B) Distortion of main field flux ☒
- C) Improvement in commutation
- D) Increase in resistance

Answer: B) Distortion of main field flux

**6. Interpoles in DC machines are used to:**

- A) Reduce hysteresis loss
- B) Improve commutation ☒
- C) Reduce copper loss
- D) Increase efficiency

Answer: B) Improve commutation

**7. The open-circuit characteristic of a DC generator is also called:**

- A) Saturation curve ☒
- B) Torque-speed curve

- C) Commutation curve
- D) Load characteristic

Answer: A) Saturation curve

**8. In a DC generator, commutator converts:**

- A) DC  $\rightarrow$  AC
- B) AC  $\rightarrow$  DC ☒
- C) AC  $\rightarrow$  AC
- D) DC  $\rightarrow$  DC

Answer: B) AC  $\rightarrow$  DC

**10. The main reason for poor commutation is:**

- A) Copper loss
- B) Armature reaction ☒
- C) Eddy currents
- D) Friction

Answer: B) Armature reaction

### DC Motor

**11. The working principle of a DC motor is based on:**

- A) Lenz's law
- B) Fleming's left-hand rule ☒
- C) Coulomb's law
- D) Fleming's right-hand rule

Answer: B) Fleming's left-hand rule

**12. In a DC motor, back EMF is:**

- A) Equal to supply voltage
- B) Opposite to supply voltage ☒
- C) Greater than supply voltage
- D) In phase with supply voltage

Answer: B) Opposite to supply voltage

**13. If field flux is reduced, speed of DC motor:**

- A) Decreases
- B) Increases ☒
- C) Remains constant
- D) Reverses

Answer: B) Increases

**16. The condition for maximum efficiency of a DC motor is:**

- A) Copper loss = Constant loss ☒
- B) Copper loss > Constant loss
- C) Iron loss = Copper loss
- D) Copper loss < Constant loss

Answer: A) Copper loss = Constant loss

**17. Which type of DC motor is used in electric traction?**

- A) Shunt                      B) Series ☒  
 C) Compound              D) Differential

Answer: B) Series

**18. The back EMF in a DC motor increases when:**

- A) Speed increases ☒ B) Field flux decreases  
 C) Load increases        D) Voltage decreases

Answer: A) Speed increases

**19. Which of the following is a constant loss in DC machines?**

- A) Armature copper loss B) Eddy current loss ☒  
 C) Series field copper loss  
 D) Load copper loss

Answer: B) Eddy current loss

**20. The efficiency of a DC motor is maximum when:**

- A) Armature current = maximum  
 B) Copper loss = Constant loss ☒  
 C) Speed is maximum  
 D) Field flux = maximum

Answer: B) Copper loss = Constant loss

## Synchronous Machines

### 1. Frequency – Poles – Speed Relation

- Frequency of generated EMF:

$$f = \frac{PN}{120}$$

Where:

- $f$  = frequency (Hz)
- $P$  = number of poles
- $N$  = speed in RPM

👉 For synchronous motor:

$$N_s = \frac{120}{P}$$

$$N_s = 120f/p$$

## 2. EMF Equation of Alternator

$$E_{ph} = 4.44f\Phi Tk_w$$

Where:

- $f$  = frequency
- $\Phi$  = flux per pole (Wb)
- $T$  = turns per phase
- $k_w$  = winding factor =  $k_p k_d$

Line voltage for star connection:

$$E_L = \sqrt{3}E_{ph}$$

Parallel Operation of Alternators

For successful parallel operation:

1. Same voltage rating
2. Same frequency
3. Same phase sequence
4. Same phase angle

Synchronization methods:

- Lamp method
- Synchroscope

MCQ Tip: Phase sequence mismatch → short circuit.

## 6. Synchronization Conditions

- Alternator must have:
  - Same frequency
  - Same phase sequence
  - Same voltage magnitude
  - Phase angle = zero

1. The synchronous speed of a 50 Hz, 6-pole alternator is:

- A) 1000 RPM
- B) 1200 RPM
- C) 1500 RPM
- D) 3000 RPM

Answer: B) 1000 RPM

$$N_s = \frac{120f}{P} = \frac{120 \times 50}{6} = 1000 \text{ RPM}$$

2. The frequency of generated EMF in a 4-pole alternator running at 1500 RPM is:

- A) 25 Hz
- B) 50 Hz ☒
- C) 75 Hz
- D) 100 Hz

Answer: B) 50 Hz

$$f = \frac{PN}{120} = \frac{4 \times 1500}{120} = 50 \text{ Hz}$$

3. The winding factor of an alternator is:

- A) > 1
- B) < 1 ☒
- C) = 1
- D) Infinite

Answer: B) Always less than 1

4. The main reason for using short-pitch coils in alternators is:

- A) Reduce copper loss
- B) Improve voltage regulation
- C) Reduce harmonics ☒
- D) Increase EMF

Answer: C) Reduce harmonics

6. The equivalent circuit of an alternator consists of:

- A) Resistance only
- B) Inductance only
- C) Resistance + Synchronous reactance ☒
- D) Pure capacitor

Answer: C) Resistance + Synchronous reactance

8. Voltage regulation of an alternator is defined as:

- A)  $\frac{V-E_0}{V} \times 100$
- B)  $\frac{E_0-V}{V} \times 100$  ☒
- C)  $\frac{E}{I}$
- D)  $\frac{P}{VI}$

Answer: B)  $\frac{E_0-V}{V} \times 100$

**9. A negative voltage regulation occurs in alternators operating at:**

- A) Lagging PF
- B) Leading PF ☒
- C) Unity PF
- D) Zero PF

Answer: B) Leading PF

**10. A synchronous condenser is used for:**

- A) Voltage control
- B) Speed control
- C) Power factor improvement ☒
- D) Frequency control

Answer: C) Power factor improvement

**11. For successful parallel operation of alternators, the condition not required is:**

- A) Same frequency
- B) Same phase sequence
- C) Same excitation voltage
- D) Same load ☒

Answer: D) Same load

**12. A mismatch in phase sequence during synchronization will cause:**

- A) Reduced voltage
- B) Reduced frequency
- C) Short-circuit ☒
- D) Power factor improvement

Answer: C) Short-circuit

**13. Which instrument is used for exact synchronization?**

- A) Voltmeter
- B) Ammeter
- C) Synchroscope ☒
- D) Tachometer

Answer: C) Synchroscope

**14. The load sharing between alternators in parallel depends on:**

- A) Speed
- B) Excitation ☒
- C) Armature current
- D) Resistance

Answer: B) Excitation

**15. A synchronous motor always runs at:**

- A) Below synchronous speed
- B) Synchronous speed ☒
- C) Above synchronous speed
- D) Variable speed

Answer: B) Synchronous speed

**16. A synchronous motor is:**

- A) Self-starting
- B) Not self-starting ☒
- C) Always induction type
- D) Variable speed

Answer: B) Not self-starting

**17. The power developed in a synchronous motor is maximum when load angle ( $\delta$ ) is:**

- A)  $0^\circ$
- B)  $45^\circ$
- C)  $90^\circ$  ☒
- D)  $180^\circ$

Answer: C)  $90^\circ$

**19. The synchronous motor can operate at:**

- A) Lagging PF only
- B) Unity PF only
- C) Leading or lagging PF ☒
- D) Zero PF only

Answer: C) Leading or lagging PF

## Induction Motors

$$\text{Slip } (s) = (N_s - N)/N_s$$

here,  $N_s$  = Synchronous Speed (RPM)

$N$  = rotor speed

At synchronous speed,  $s = 0$

At standstill,  $s = 1$

### Tests

- No-load Test:
  - Conducted at rated voltage & frequency.
  - Determines core loss, friction & windage loss.
- Blocked Rotor Test:
  - Rotor blocked (slip = 1).
  - Determines equivalent circuit parameters

### MCQ Tip:

- No-load test → gives constant losses.
- Blocked-rotor test → gives short-circuit parameters.

**The starting torque of a squirrel cage induction motor is:**

- A) Very high                      B) Low ☒
- C) Zero                              D) Adjustable

**Answer:** B) Low

**The starting torque of a slip-ring induction motor is:**

- A) Low                              B) High ☒
- C) Zero                              D) Always constant

**Answer:** B) High (due to external rotor resistance)

**5. The condition for maximum torque in an induction motor is:**

- A)  $R_2 = sX_2$  ☒
- B)  $R_2 = X_2$
- C)  $s = 0$
- D)  $R_1 = X_1$

**Answer:** A)  $R_2 = sX_2$

**The maximum torque of an induction motor depends on:**

- A) Rotor resistance                      B) Supply voltage & rotor reactance ☒
- C) Slip                                          D) Speed

Answer: B) Supply voltage & rotor reactance (independent of rotor resistance).

**Which test on induction motor is used to determine constant losses?**

- A) Blocked rotor test                      B) No-load test ☒
- C) Short-circuit test                        D) Open-circuit test

Answer: B) No-load test

**The speed control by adding resistance in rotor circuit is possible only in:**

- A) Squirrel cage IM                        B) Slip-ring IM ☒
- C) Both                                          D) None

Answer: B) Slip-ring IM

**In an induction motor, the rotor input power is equal to:**

- A) Rotor copper loss + Mechanical power ☒
- B) Stator copper loss + Iron loss
- C) Shaft power + Core loss
- D) Air-gap power + Constant loss

Answer: A) Rotor copper loss + Mechanical power

## Transformer – Exclusive MCQ Notes

### 1. EMF Equation

- $E_1 = 4.44fN_1\phi_m$  (Primary induced EMF)
- $E_2 = 4.44fN_2\phi_m$  (Secondary induced EMF)
- Turns Ratio:  $\frac{E_2}{E_1} = \frac{N_2}{N_1} = K$

## 2. Equivalent Circuit

- Series Resistance  $\rightarrow R_1, R_2$
  - Leakage Reactance  $\rightarrow X_1, X_2$
  - Core Loss Component  $\rightarrow R_c$  (accounts for hysteresis & eddy loss)
  - Magnetizing Component  $\rightarrow X_m$
  - Referred to Primary/Secondary for simplification.
- 

## 3. Voltage Regulation

- Formula:

$$\%VR = \frac{V_{nl} - V_{fl}}{V_{fl}} \times 100$$

- Lagging PF  $\rightarrow$  **Positive VR**
  - Leading PF  $\rightarrow$  **Negative VR**
- 

## 4. Efficiency ( $\eta$ )

- Formula:

$$\eta = \frac{\text{Output}}{\text{Output} + \text{Losses}} \times 100$$

- Losses = Iron Loss (constant) + Copper Loss (variable).
  - **Condition for Max Efficiency**  $\rightarrow$  Iron Loss = Copper Loss.
-

## 5. OC & SC Tests

- **Open Circuit (OC) Test:**
  - Conducted on **LV side** (HV open).
  - Gives **Iron Loss** and **Magnetizing current**.
- **Short Circuit (SC) Test:**
  - Conducted on **HV side** (LV shorted).
  - Gives **Copper Loss** and **Equivalent Impedance**.

## 6. Auto-transformer

- Single winding acts as **both primary & secondary**.
- Copper saving =  $1 - \frac{V_2}{V_1}$ .
- More economical for **small voltage ratio**.
- Not suitable where **isolation** is required.

## 7. Transformer Connections

- **Star-Star (Y-Y)** → Suitable for **high voltage, long distance transmission**.
- **Delta-Delta (Δ-Δ)** → Good for **low voltage, high current applications**.
- **Star-Delta (Y-Δ)** → Step-down transformer, phase shift =  $-30^\circ$ .
- **Delta-Star (Δ-Y)** → Step-up transformer, phase shift =  $+30^\circ$ .

### Parallel Operation of Transformers

- **Conditions:**
  1. Same polarity.
  2. Same voltage ratio.
  3. Same % Impedance.
  4. Same phase sequence & vector group.
- Otherwise → circulating current & unequal load sharing.

**1. The EMF equation of a transformer is:**

- A)  $E = 2.22fN\phi_m$
- B)  $E = 4.44fN\phi_m$  ✓
- C)  $E = 1.11fN\phi_m$
- D)  $E = 3.33fN\phi_m$

**Explanation:** Average induced EMF per turn =  $4.44f\phi_m$ .

**2. In a transformer, EMF ratio is equal to:**

- A) Current ratio
- B) Power ratio
- C) Turns ratio ✓
- D) Loss ratio

**Explanation:**  $\frac{E_2}{E_1} = \frac{N_2}{N_1} = K$ .

**3. The equivalent circuit of a transformer includes:**

- A) Only resistance
- B) Only reactance
- C) Resistance, reactance,  $R_c$ ,  $X_m$  ✓
- D) Only  $R_c$  and  $X_m$

**Explanation:** Practical model includes winding resistance, leakage reactance, and core-loss/magnetizing branches.

**4. The parameter representing core loss in equivalent circuit is:**

- A)  $R_c$  ✓
- B)  $X_m$
- C)  $R_1$
- D)  $X_1$

**Explanation:**  $R_c$  (core loss resistance) accounts for hysteresis & eddy loss.

**5. Voltage regulation of transformer is:**

- A) Always positive
- B) May be positive or negative ✓
- C) Always negative
- D) Zero only at unity PF

**Explanation:** At lagging PF → positive; at leading PF → negative.

**6. Which load condition gives negative VR?**

- A) Resistive load                      B) Lagging power factor load  
C) Leading power factor load ☒                      D) Unity PF load

Explanation: Leading PF causes voltage rise at load, giving negative VR.

**7. Transformer efficiency ( $\eta$ ) is maximum when:**

- A) Iron loss = Copper loss ☒                      B) Iron loss > Copper loss  
C) Iron loss < Copper loss                      D) Copper loss = 0

Explanation: Condition for max efficiency is  $P_i = P_c$ .

**8. Which test gives iron loss?**

- A) Short circuit test                      B) Open circuit test ☒  
C) Load test                      D) None

Explanation: OC test  $\rightarrow$  core loss; SC test  $\rightarrow$  copper loss.

**9. In SC test, which side is shorted?**

- A) LV side ☒                      B) HV side  
C) Both sides                      D) Secondary open

Explanation: HV is applied at low voltage, LV is shorted.

**10. In OC test, supply is applied to:**

- A) LV side ☒                      B) HV side  
C) Both                      D) None

Explanation: OC test conducted on LV side for safety.

**11. Auto-transformer uses:**

- A) Two separate windings                      B) Single winding ☒  
C) Two cores                      D) Multiple cores

Explanation: Primary & secondary share common winding.

**12. Copper saving in auto-transformer is maximum when:**

- A) Transformation ratio is large                      B) Transformation ratio is small ☒  
C) Always constant                      D) Never saved

**13. Main disadvantage of auto-transformer is:**

- A) Higher cost                      B) Poor efficiency  
C) No electrical isolation ☒                      D) Higher losses

Explanation: Same winding  $\rightarrow$  no isolation.

**14. Star-star connection is used for:**

- A) Low voltage, high current                      B) High voltage, long distance transmission ☒  
C) Traction                      D) Distribution only

Explanation: Neutral availability & insulation savings.

**15. Delta-delta connection is suitable for:**

- A) High voltage transmission      B) Low voltage, high current applications ☒
- C) Single-phase loads      D) Auto-transformer

Explanation:  $\Delta$ - $\Delta$  withstands unbalanced load, used in low voltage.

**16. Star-delta connection introduces phase shift of:**

- A)  $0^\circ$       B)  $-30^\circ$  ☒
- C)  $+30^\circ$       D)  $60^\circ$

Explanation: Y- $\Delta$  gives  $-30^\circ$  shift.

**17. Delta-star connection introduces phase shift of:**

- A)  $+30^\circ$  ☒      B)  $-30^\circ$
- C)  $60^\circ$       D)  $0^\circ$

Explanation:  $\Delta$ -Y gives  $+30^\circ$  shift.

**18. Condition for parallel operation of transformers includes:**

- A) Same turns ratio ☒      B) Different vector groups
- C) Unequal % impedance      D) Different polarity

Explanation: Must have same polarity, ratio, %Z, sequence.

**19. If polarity is not same in parallel operation:**

- A) Transformers share load equally      B) Large circulating current flows ☒
- C) Efficiency increases      D) Load reduces

Explanation: Wrong polarity  $\rightarrow$  short-circuiting.

**20. Transformer efficiency is highest at:**

- A) No load      B) Full load
- C) Load where  $P_i = P_c$  ☒      D) 50% load

Explanation: Max efficiency condition is  $P_i = P_c$ .

**21. Which loss is constant in transformer?**

- A) Copper loss      B) Iron loss ☒
- C) Stray loss      D) Mechanical loss

Explanation: Iron loss depends only on voltage, not load.

**22. In a practical transformer, primary and secondary current are related by:**

- A)  $I_1/I_2 = N_1/N_2$  ✓
- B)  $I_1/I_2 = N_2/N_1$
- C)  $I_1 = I_2$
- D) None

**Explanation:** Current ratio is inverse of turns ratio.

**23. In ideal transformer, efficiency is:**

- A) 100% ✓
- B) 75%
- C) 50%
- D) 90%

**Explanation:** No losses in ideal case.

**24. Leakage reactance is due to:**

- A) Core leakage
- B) Leakage flux not linking both windings ✓
- C) Insulation defect
- D) Eddy currents

**Explanation:** Some flux doesn't link both windings → reactance.

**25. No-load current of the transformer is about:**

- A) 1-3% of rated current ✓
- B) 10%
- C) 25%
- D) 50%

**Explanation:** Only small magnetizing + core loss current flows.

**26. The instrument used to check the polarity of a transformer is:**

- A) Wattmeter
- B) Voltmeter ✓
- C) Ammeter
- D) Ohmmeter

**Explanation:** Polarity test done by voltmeter.

**27. Which test determines copper loss at full load?**

- A) Open circuit
- B) Short circuit ✓
- C) Polarity test
- D) Load test

**Explanation:** SC test gives full-load copper loss.

**28. Transformer cannot change:**

- A) Voltage
- B) Power ✓
- C) Current
- D) Frequency

**Explanation:** Transformer ideally keeps power same (neglecting loss).

**29. The purpose of using laminated core is to reduce:**

- A) Hysteresis loss
- B) Eddy current loss ✓
- C) Copper loss
- D) Stray loss

**Explanation:** Lamination increases resistance to eddy currents.

**30. The kVA rating of transformer depends on:**

- A) Voltage only                      B) Current only  
C) Both voltage & current                       D) Power factor

Explanation:  $kVA = V \times I$ , independent of PF

**Power System – Basics****1. Single Line Diagram (SLD)**

- Represents a power system using single lines & standard symbols for generators, transformers, transmission lines, loads, and circuit breakers.
- Shows power flow path and major equipment ratings.
- Advantage: Simplifies analysis of 3-phase system.
- Breaker symbol = double line with a small gap.
- Bus bar = thick horizontal line.

**2. Per-Unit (p.u.) System**

- Definition: Physical quantities expressed as a fraction of chosen base value.
- Formula:

$$\text{p.u. value} = \text{Actual Value} / \text{Base Value}$$

- Base kVA is same for all components.
- Per-unit values make calculations independent of voltage level.
- Advantages: Easier fault analysis, reduces error, comparison possible.
- In transformers: Impedance in p.u. is same on primary and secondary side.

**3. Transmission Line Parameters**

- Parameters: R (Resistance), L (Inductance), C (Capacitance), G (Leakage conductance).

Short Line (<80 km, <69 kV):

- Only R & X considered.
- $\pi$  or T model not needed.

Medium Line (80–250 km, 69–220 kV):

- Nominal  $\pi$ -model or Nominal T-model used.
- Includes R, X, C.

Long Line (>250 km, >220 kV):

- Treated as distributed parameters.
- Use Hyperbolic functions (A, B, C, D constants).

#### 4. Symmetrical & Unsymmetrical Faults

- Symmetrical (Balanced) Faults:
  - 3-phase fault (LLL or LLLG).
  - Most severe  $\rightarrow$  highest current.
  - Probability < 5%.
- Unsymmetrical (Unbalanced) Faults:
  - Types:
    - Single Line to Ground (L-G)  $\rightarrow$  Most common (~70%).
    - Line to Line (L-L).
    - Double Line to Ground (L-L-G).
  - Requires symmetrical component method for analysis.

#### 5. Symmetrical Components

- Proposed by C. L. Fortescue.
- Any unbalanced system can be resolved into:
  1. Positive Sequence (Balanced, same phase order as original).
  2. Negative Sequence (Balanced, reverse phase order).
  3. Zero Sequence (All three phases in phase).
- Used in fault analysis & protection system design.

## 6. Power Angle Equation

- For a simple lossless transmission line:

$$P = \frac{EV}{X} \sin \delta$$

- $E$  = Sending end voltage,
- $V$  = Receiving end voltage,
- $X$  = Reactance of line,
- $\delta$  = Load angle (power angle).
- Max power transfer** occurs at  $\delta = 90^\circ$ .

## 7. Equal Area Criterion

- A graphical method for transient stability analysis.
- Stable operation:
  - Accelerating area = Decelerating area.
- Unstable if accelerating area > decelerating area.
- Applied in single-machine infinite bus (SMIB) system.
- Critical clearing angle & time can be determined.

### 1. Single Line Diagram

**Q1.** A single line diagram is mainly used to represent:

- |                                            |                                       |
|--------------------------------------------|---------------------------------------|
| a) Voltage and current waveforms           | b) Power system with all three phases |
| c) Power system using symbols and one line | d) Only transmission lines            |

👉 **Answer:** c

**Explanation:** SLD uses one line and standard symbols to represent a complete 3-phase power system.

**Q2.** The main advantage of per-unit system is:

- Only used for short circuit calculations
- Impedance values are independent of voltage level
- Reduces the number of circuit breakers
- Removes harmonics from the system

**Answer:** b

**Explanation:** In p.u. system, transformer impedance remains same on both primary and secondary side, independent of voltage level.

**Q3.** Per-unit value is given by:

- |                                     |                                   |
|-------------------------------------|-----------------------------------|
| a) Actual Value $\times$ Base Value | b) Actual Value $\div$ Base Value |
| c) Base Value $\div$ Actual Value   | d) Actual Value $-$ Base Value    |

**Answer:** b

**Explanation:** Per-unit = Actual  $\div$  Base.

### 3. Transmission Line Parameters

**Q4.** For a **short transmission line** (<80 km), which parameters are considered?

- |               |                   |
|---------------|-------------------|
| a) R and C    | b) R and X        |
| c) R, X and C | d) R, L, C, and G |

**Answer:** b

**Explanation:** Capacitance effect negligible for short lines.

**Q5.** Nominal  $\pi$ -model is used for:

- |               |                      |
|---------------|----------------------|
| a) Short line | b) Medium line       |
| c) Long line  | d) Distribution line |

**Answer:** b

**Explanation:** Medium transmission lines (80–250 km) require  $\pi$  or T model with R, L, C.

**Q6.** Long transmission lines are analyzed using:

- |                                                     |                      |
|-----------------------------------------------------|----------------------|
| a) Equivalent $\pi$ circuit                         | b) Lumped parameters |
| c) Distributed parameters with hyperbolic functions | d) RLC filter method |

**Answer:** c

**Explanation:** Long lines (>250 km) require distributed parameters with ABCD constants.

### 4. Faults

**Q7.** The most severe type of fault is:

- |                          |                      |
|--------------------------|----------------------|
| a) Single line to ground | b) Line to line      |
| c) Double line to ground | d) Three phase fault |

**Answer:** d

**Explanation:** 3-phase fault causes maximum fault current but occurs less often.

**Q8.** The most common type of fault in a power system is:

- |                  |                |
|------------------|----------------|
| a) 3-phase fault | b) L-L fault   |
| c) L-G fault     | d) L-L-G fault |

**Answer:** c

**Explanation:** ~70% of faults are single line-to-ground (L-G).

## 5. Symmetrical Components

**Q9.** Symmetrical component method was proposed by:

- a) Steinmetz
- b) C. L. Fortescue
- c) Maxwell
- d) Charles Proteus

**Answer:** b

**Explanation:** In 1918, Fortescue introduced symmetrical components.

**Q10.** Zero-sequence components in a three-phase system are:

- a) Balanced and same phase order
- b) Balanced but reverse order
- c) Three equal vectors displaced by  $120^\circ$
- d) Three equal vectors in phase

**Answer:** d

**Explanation:** Zero-sequence = all three phasors equal in magnitude & in phase.

**Q11.** Positive sequence components are:

- a) Same order as original system
- b) Opposite order to original system
- c) All three in phase
- d) None of these

**Answer:** a

**Explanation:** Positive sequence has same phase order (ABC).

## 6. Power Angle Equation

**Q12.** The maximum power transfer in a lossless line occurs at:

- a)  $\delta = 0^\circ$
- b)  $\delta = 30^\circ$
- c)  $\delta = 60^\circ$
- d)  $\delta = 90^\circ$

**Answer:** d

## 7. Equal Area Criterion

**Q14.** Equal area criterion is used for:

- a) Steady-state stability
- b) Transient stability
- c) Small-signal stability
- d) Voltage stability

**Answer:** b

**Explanation:** It is a graphical method for transient stability analysis.

**Q15.** System is stable if:

- a) Accelerating area > Decelerating area
- b) Accelerating area < Decelerating area
- c) Accelerating area = Decelerating area
- d) No accelerating area

**Answer:** c

**Explanation:** Stability condition = both areas equal.

**Q16.** Equal area criterion is most commonly applied to:

- a) Infinite bus + load
- b) Single Machine Infinite Bus (SMIB) system
- c) Small isolated system
- d) Distribution feeders

**Answer:** b

**Explanation:** Widely used for SMIB.

### Mixed Revision

**Q17.** In per-unit system, transformer impedance is:

- |                            |                       |
|----------------------------|-----------------------|
| a) Different on both sides | b) Same on both sides |
| c) Doubled on HV side      | d) Neglected          |

**Answer:** b

**Q18.** The main purpose of symmetrical components is:

- |                            |                           |
|----------------------------|---------------------------|
| a) Voltage regulation      | b) Fault analysis         |
| c) Power factor correction | d) Efficiency improvement |

**Answer:** b

**Q19.** For a 3-phase fault analysis, which sequence component is used?

- |                           |                           |
|---------------------------|---------------------------|
| a) Only positive sequence | b) Only negative sequence |
| c) Only zero sequence     | d) All three sequences    |

**Answer:** a

**Explanation:** Balanced fault → only positive sequence network used.

**Q20.** Which fault involves two conductors and ground?

- |          |            |
|----------|------------|
| a) L-G   | b) L-L     |
| c) L-L-G | d) 3-Phase |

**Answer:** c

## Power System – Protection

### ◆ Circuit Breakers

#### 1. Principle of Arc Extinction

- When a breaker opens → arc forms between contacts.
- Arc must be extinguished for successful interruption.
- Two main methods:
  1. High resistance method → Resistance of arc increased until current becomes too small.
  2. Low resistance method → Current forced to pass zero & arc is cooled, ionization reduced.
- In AC systems: Current naturally passes through zero → arc extinction easier.

## 2. Types of Circuit Breakers

1. Air Circuit Breaker (ACB):
  - Uses air at atmospheric pressure as arc quenching medium.
  - Used up to 11 kV.
  - Simple, low-cost, but bulky.
2. Oil Circuit Breaker (OCB):
  - Oil acts as insulator & arc extinguishing medium.
  - Arc vaporizes oil → hydrogen formed → cools arc.
  - Fire hazard, requires maintenance.
3. Vacuum Circuit Breaker (VCB):
  - Arc occurs in vacuum → no ionization.
  - High dielectric strength, long life.
  - Best for up to 66 kV.
4. SF<sub>6</sub> Circuit Breaker:
  - Uses sulphur hexafluoride gas (excellent dielectric).
  - Arc quickly cooled by gas.
  - Used for high voltage > 220 kV.
  - Expensive but reliable.

## 3. Recovery Voltage

- Definition: Voltage appearing across breaker contacts immediately after arc extinction.
- Peak value & rate of rise important → breaker must withstand it.
- If not, arc may restrike.

## ◆ Protective Relays

### 1. Overcurrent Relay

- Operates when current > preset value.
- Simple, inexpensive.
- Used in feeder protection.

### 2. Differential Relay

- Compares currents entering & leaving equipment.
- If difference > preset → fault inside equipment.

- Used for transformer, generator, busbar protection.

### 3. Impedance Relay

- Based on  $Z = V/I$  measurement.
- Operates when measured impedance < set value.
- Used in distance protection of transmission lines.

### 4. Mho Relay

- A type of distance relay.
- Operating region is a circle passing through origin in R-X diagram.
- Provides directional feature → effective for long transmission lines.

### 5. IDMT Relay (Inverse Definite Minimum Time)

- Time of operation inversely proportional to fault current.
- High fault current → operates faster.
- Minimum time limit present → avoids maloperation.
- Commonly used as overcurrent protection in feeders.

### ◆ Protection Applications

- Generator Protection:
  - Differential protection
  - Overcurrent & earth fault protection
  - Loss of excitation protection
- Transformer Protection:
  - Differential relay
  - Buchholz relay (for oil transformers)
  - Overcurrent & earth fault relays
- Busbar Protection:
  - Differential scheme (fast & reliable).
  - Requires high-speed relays.

**Q1.** The main purpose of a circuit breaker is:

- |                                 |                               |
|---------------------------------|-------------------------------|
| a) To step up voltage           | b) To interrupt fault current |
| c) To increase system frequency | d) To improve power factor    |

**Answer: b**

**Explanation:** CB protects system by interrupting abnormal current.

---

**Q2.** The arc in a circuit breaker is produced due to:

- |                         |                        |
|-------------------------|------------------------|
| a) Low resistance       | b) High inductance     |
| c) Ionization of medium | d) Capacitive charging |

**Answer: c**

---

**Q3.** In AC circuit breakers, arc extinction is easier because:

- |                       |                                        |
|-----------------------|----------------------------------------|
| a) Voltage is low     | b) Current passes through natural zero |
| c) Resistance is high | d) Frequency is constant               |

**Answer: b**

**Q4.** The recovery voltage is:

- |                                       |                                                 |
|---------------------------------------|-------------------------------------------------|
| a) Voltage across contacts during arc | b) Voltage across contacts after arc extinction |
| c) Voltage across healthy phases      | d) Supply voltage                               |

**Answer: b**

**Q5.** Arc extinction by high resistance method means:

- |                             |                             |
|-----------------------------|-----------------------------|
| a) Arc resistance decreased | b) Arc resistance increased |
| c) Arc length reduced       | d) Arc cooled               |

**Answer: b**

**Q6.** Which circuit breaker uses **oil** as arc extinguishing medium?

- |        |                       |
|--------|-----------------------|
| a) ACB | b) OCB                |
| c) VCB | d) SF <sub>6</sub> CB |

**Answer: b**

**Q7.** The major drawback of oil circuit breakers is:

- |                |                            |
|----------------|----------------------------|
| a) High cost   | b) Large size              |
| c) Fire hazard | d) Low dielectric strength |

**Answer: c**

**Q8.** Which breaker has highest dielectric strength?

- |        |                       |
|--------|-----------------------|
| a) ACB | b) OCB                |
| c) VCB | d) SF <sub>6</sub> CB |

**Answer: d**

**Q9.** Vacuum circuit breakers are generally used up to:

- |          |           |
|----------|-----------|
| a) 11 kV | b) 33 kV  |
| c) 66 kV | d) 220 kV |

**Answer: c**

**Q10.** SF<sub>6</sub> gas has:

- a) Low dielectric strength
- b) High dielectric & arc quenching property
- c) No dielectric property
- d) Flammable property

**Answer:** b

◆ Protective Relays

**Q11.** An overcurrent relay operates when:

- a) Voltage exceeds set value
- b) Current exceeds set value
- c) Frequency exceeds set value
- d) Power exceeds set value

**Answer:** b

**Q12.** Overcurrent relays are mainly used for:

- a) Transmission line distance protection
- b) Busbar protection
- c) Feeder protection
- d) Generator rotor protection

**Answer:** c

**Q13.** Differential protection works on the principle of:

- a) Current comparison
- b) Voltage balance
- c) Frequency shift
- d) Power angle

**Answer:** a

**Q14.** Transformer differential protection uses:

- a) Mho relay
- b) IDMT relay
- c) Differential relay
- d) Overvoltage relay

**Answer:** c

**Q15.** Buchholz relay is used for:

- a) Bus protection
- b) Transformer protection
- c) Feeder protection
- d) Generator protection

**Answer:** b

**Q16.** Distance protection relay operates based on:

- a) Current magnitude
- b) Voltage magnitude
- c) Impedance (V/I)
- d) Frequency

**Answer:** c

**Q17.** Mho relay is a type of:

- a) Overcurrent relay
- b) Differential relay
- c) Distance relay
- d) Buchholz relay

**Answer:** c

**Q18.** The characteristic of mho relay in R-X plane is:

- a) Circle through origin
- b) Straight line
- c) Square
- d) Ellipse

**Answer: a**

**Q19.** IDMT relay operating time is:

- a) Directly proportional to current
- b) Inversely proportional to current
- c) Independent of current
- d) Independent of time

**Answer: b**

**Q20.** IDMT relay is commonly used in:

- a) Generator protection
- b) Transformer protection
- c) Feeder protection
- d) Busbar protection

**Answer: c**

#### ◆ Generator / Transformer / Bus Protection

**Q21.** Main protection used for generators is:

- a) Overcurrent relay
- b) Differential protection
- c) Mho relay
- d) IDMT relay

**Answer: b**

**Q22.** Loss of excitation protection is required for:

- a) Transmission lines
- b) Generators
- c) Transformers
- d) Busbars

**Answer: b**

**Q23.** Transformer gas faults are detected by:

- a) Differential relay
- b) Buchholz relay
- c) Mho relay
- d) IDMT relay

**Answer: b**

**Q24.** Busbar protection usually employs:

- a) Differential relay
- b) Overcurrent relay
- c) IDMT relay
- d) Impedance relay

**Answer: a**

**Q25.** Generator protection against stator winding fault is:

- a) Overvoltage relay
- b) Differential relay
- c) Mho relay
- d) Buchholz relay

**Answer: b**

#### ◆ Mixed Quick Questions

**Q26.** Which CB is NOT suitable for high voltage?

- a) OCB
- b) ACB
- c) VCB
- d) SF<sub>6</sub> CB

**Answer: b**

**Q27.** SF<sub>6</sub> circuit breakers are used in:

- |                                         |                              |
|-----------------------------------------|------------------------------|
| a) Low voltage circuits only            | b) Medium voltage circuits   |
| c) Extra high voltage systems (>220 kV) | d) Distribution transformers |

**Answer:** c

**Q28.** In differential protection, relay operates when:

- |                |                   |
|----------------|-------------------|
| a) $I_1 = I_2$ | b) $I_1 \neq I_2$ |
| c) $V_1 = V_2$ | d) $P = Q$        |

**Answer:** b

**Q29.** Distance protection is mainly applied to:

- |                       |                 |
|-----------------------|-----------------|
| a) Generators         | b) Transformers |
| c) Transmission lines | d) Motors       |

**Answer:** c

**Q30.** Which of the following relays has a minimum time characteristic?

- |                       |                      |
|-----------------------|----------------------|
| a) Differential relay | b) Overcurrent relay |
| c) IDMT relay         | d) Buchholz relay    |

**Answer:** c

## Power Plant Engineering

### Load Curves

- Load Curve: Graph between load (MW) and time (hours).
- Daily Load Curve: Variation of load during 24 hours.
- Monthly/Yearly Load Curve: Shows seasonal variations.
- Load Duration Curve: Loads arranged in descending order → shows load vs % time.
- Importance: Helps in plant design, capacity planning, and cost calculation.

### ◆ Base Load vs Peak Load

- Base Load:
  - Continuous minimum demand of a power system.
  - Supplied by base load plants (thermal, nuclear, hydro).
  - Operate most of the time at high efficiency.
- Peak Load:
  - Load demand above base load during peak hours.
  - Supplied by peaking plants (gas turbines, hydro).
  - Operates only during peak demand → less efficient but quick start.

### ◆ Plant Location Factors

- Selection of site depends on:
  1. Availability of fuel (coal, gas, uranium).
  2. Water supply (for cooling, steam generation).
  3. Transport facilities (rail/road/port).
  4. Nearness to load center (reduces transmission losses).
  5. Land cost & availability.
  6. Environmental & safety concerns.

### ◆ Performance Characteristics

- Efficiency ( $\eta$ ):

$$\eta = (\text{Output Power} / \text{Input Power}) \times 100$$

- Higher efficiency  $\rightarrow$  lower fuel cost.

- Plant Load Factor (PLF):

$$\text{Load Factor} = \text{Average Load} / \text{Maximum Demand}$$

- Capacity Factor:

$$\text{Plant Capacity Factor (PCF)} = \text{Actual Energy Generated} / \text{Maximum Possible Energy Generation}$$

### ◆ Nuclear Power Basics

- Nuclear Fission: Heavy nucleus (U-235, Pu-239) splits into smaller nuclei  $\rightarrow$  releases energy + neutrons.
- Chain Reaction:
  - Fission of one atom releases neutrons  $\rightarrow$  cause further fission.
  - Controlled in reactors using control rods (boron, cadmium).
- Moderators:
  - Reduce neutron speed to sustain chain reaction.
  - Common moderators: Graphite, Heavy water, Light water.
- Coolants:
  - Remove heat from reactor core.
  - Examples: CO<sub>2</sub>, Na, Light/Heavy water.

- Types of Reactors:
  - Pressurized Water Reactor (PWR) – uses light water as coolant & moderator.
  - Boiling Water Reactor (BWR) – water boils in core, steam drives turbine.
  - Fast Breeder Reactor (FBR) – no moderator, uses fast neutrons, produces more fuel.

### Load Curves

**Q1.** A **load curve** shows variation of:

- |                         |                                |
|-------------------------|--------------------------------|
| a) Voltage with time    | b) Load (MW) with time         |
| c) Current with voltage | d) Power factor with frequency |

**Answer:** b

**Q2.** A **load duration curve** is obtained by:

- |                                             |                                              |
|---------------------------------------------|----------------------------------------------|
| a) Arranging daily loads in ascending order | b) Arranging daily loads in descending order |
| c) Plotting load vs temperature             | d) Plotting load vs frequency                |

**Answer:** b

**Q3.** The main purpose of a load curve is to:

- |                           |                                                 |
|---------------------------|-------------------------------------------------|
| a) Show system efficiency | b) Assist in plant design and capacity planning |
| c) Calculate power factor | d) Determine cooling requirements               |

**Answer:** b

**Q4.** Peak demand occurs:

- |                        |                     |
|------------------------|---------------------|
| a) During minimum load | b) During base load |
| c) During maximum load | d) At night only    |

**Answer:** c

**Q5.** Daily load curve typically covers:

- |             |             |
|-------------|-------------|
| a) 12 hours | b) 24 hours |
| c) 1 week   | d) 1 month  |

**Answer:** b

### ◆ Base Load vs Peak Load

**Q6.** Base load plants are generally:

- |                              |                         |
|------------------------------|-------------------------|
| a) Gas turbines              | b) Hydro peaking plants |
| c) Thermal or nuclear plants | d) Diesel generators    |

**Answer:** c

**Q7.** Peaking plants are preferred because:

- |                                 |                                   |
|---------------------------------|-----------------------------------|
| a) High efficiency at all times | b) Quick startup during peak load |
| c) Large fuel storage           | d) Continuous operation           |

**Answer:** b

**Q8.** Base load is the:

- a) Maximum daily demand
- b) Minimum continuous demand
- c) Average load
- d) Load at night

**Answer:** b

**Q9.** Peaking load is usually supplied by:

- a) Nuclear plants
- b) Steam turbines
- c) Gas turbines or hydro turbines
- d) Coal-fired plants

**Answer:** c

**Q10.** Base load plants operate:

- a) Only during daytime
- b) During peak hours
- c) Most of the time at high efficiency
- d) Only in winter

**Answer:** c

#### ◆ Plant Location Factors

**Q11.** Availability of **fuel** is a major factor in selecting plant site because:

- a) Reduces transmission losses
- b) Reduces fuel transportation cost
- c) Reduces cooling requirements
- d) Improves voltage regulation

**Answer:** b

**Q12.** Nearness to **load center** is important to:

- a) Reduce construction cost
- b) Reduce transmission losses
- c) Avoid cooling issues
- d) Increase generation capacity

**Answer:** b

**Q13.** Cooling water is required for:

- a) Generator only
- b) Transformer only
- c) Steam cycle and reactor cooling
- d) Transmission lines

**Answer:** c

**Q14.** Land availability affects plant site mainly because:

- a) Land is cheap
- b) Plant requires large area
- c) Transmission lines are costly
- d) Fuel supply is affected

**Answer:** b

**Q15.** Environmental & safety considerations are important for:

- a) Transformer efficiency
- b) Generator voltage
- c) Nuclear & thermal plants
- d) Transmission lines

**Answer:** c

### ◆ Performance Characteristics

**Q16.** Efficiency ( $\eta$ ) of a power plant is defined as:

- a)  $\text{Output} \div \text{Input} \times 100$
- b)  $\text{Input} \div \text{Output} \times 100$
- c)  $\text{Heat input} \div \text{Output}$
- d)  $\text{Average load} \div \text{Peak load}$

**Answer:** a

**Q17.** Heat rate is:

- a)  $\text{Output} \div \text{Input}$
- b)  $\text{Input energy} \div \text{Electrical energy output}$
- c)  $\text{Output} \div \text{Fuel energy}$
- d)  $\text{Load} \div \text{Time}$

**Answer:** b

**Q20.** Capacity factor is:

- a)  $\text{Maximum load} \div \text{Average load}$
- b)  $\text{Average load} \div \text{Maximum possible load}$
- c)  $\text{Actual energy generated} \div \text{Maximum possible energy}$
- d)  $\text{Output} \div \text{Fuel input}$

**Answer:** c

### ❖ Nuclear Power Basics

**Q21.** Nuclear fission involves:

- a) Small nuclei combining
- b) Heavy nucleus splitting into smaller nuclei
- c) Electron emission
- d) Neutron absorption only

**Answer:** b

**Q22.** Chain reaction is sustained by:

- a) Electrons
- b) Protons
- c) Neutrons
- d) Photons

**Answer:** c

**Q23.** Moderators in nuclear reactors are used to:

- a) Absorb heat
- b) Slow down neutrons
- c) Increase voltage
- d) Cool turbines

**Answer:** b

**Q24.** Common moderators include:

- a) Lead, mercury
- b) Graphite, heavy water, light water
- c)  $\text{CO}_2$ , Na
- d)  $\text{SF}_6$  gas

**Answer:** b

**Q25.** Coolants in nuclear reactors are used to:

- a) Slow neutrons
- b) Remove heat from core
- c) Control reactivity
- d) Increase chain reaction

**Answer:** b

**Q26.** Pressurized Water Reactor (PWR) uses:

- |                                  |                                       |
|----------------------------------|---------------------------------------|
| a) Heavy water as moderator only | b) Light water as coolant & moderator |
| c) Gas cooling                   | d) Fast neutrons                      |

**Answer:** b

**Q27.** Boiling Water Reactor (BWR) generates:

- |                                      |                                           |
|--------------------------------------|-------------------------------------------|
| a) Superheated steam outside reactor | b) Steam inside reactor to drive turbines |
| c) Only electricity                  | d) Only heat                              |

**Answer:** b

**Q28.** Fast Breeder Reactor (FBR) uses:

- |                          |                     |
|--------------------------|---------------------|
| a) Slow neutrons         | b) Fast neutrons    |
| c) Light water moderator | d) Hydrogen cooling |

**Answer:** b

**Q29.** Uranium-235 is used as:

- |              |                |
|--------------|----------------|
| a) Moderator | b) Fuel        |
| c) Coolant   | d) Control rod |

**Answer:** b

**Q30.** Control rods in a reactor are used to:

- |                                             |                                |
|---------------------------------------------|--------------------------------|
| a) Slow down neutrons                       | b) Increase fuel consumption   |
| c) Absorb neutrons & control chain reaction | d) Increase thermal efficiency |

**Answer:** c

## Renewable & Modern Systems

### Solar Cell Basics

- Photovoltaic (PV) cell converts solar energy → electricity via photoelectric effect.
- Key materials: Silicon (monocrystalline, polycrystalline, thin film).
- Open-circuit voltage (Voc): Voltage at zero current.
- Short-circuit current (Isc): Current at zero voltage.
- Efficiency factors: Irradiance, temperature, cell material, angle of incidence.
- Used in remote power, rooftop systems, satellites.

### ◆ Tidal & Biomass Energy

- Tidal Energy: Kinetic & potential energy of tides → electrical energy.
  - Uses tidal barrage, tidal stream generators.
  - Renewable & predictable.

- Biomass Energy: Organic matter (wood, crops, waste) → combustion/gasification → electricity or heat.
  - Types: Direct combustion, anaerobic digestion, gasification.
  - Considered carbon-neutral.

#### ◆ HVDC Transmission

- High Voltage Direct Current for long-distance transmission.
- Advantages: Low losses, control over power flow, connects asynchronous grids.
- Types:
  - LCC (Line Commutated Converter) – uses thyristors, requires AC voltage
  - VSC (Voltage Source Converter) – uses IGBTs, bidirectional, black-start capability
- Main components:
  1. Converter station (rectifier/inverter)
  2. Transmission line (overhead or submarine cable)
  3. Filters & reactive power compensation
  4. Control & protection system

#### ◆ FACTS Devices (Flexible AC Transmission Systems)

- Used to enhance controllability, stability, and power flow in AC systems.
- Key devices:
  1. SVC (Static Var Compensator): Shunt, controls voltage, injects reactive power.
  2. STATCOM (Static Synchronous Compensator): Advanced SVC, faster response, uses VSC.
  3. TCSC (Thyristor Controlled Series Capacitor): Series, controls line reactance → power flow.
  4. UPFC (Unified Power Flow Controller): Controls voltage, impedance, phase angle → controls real & reactive power simultaneously.

Q1. Solar cell converts:

- a) Mechanical → Electrical
- b) Thermal → Electrical
- c) Solar → Electrical
- d) Chemical → Electrical

Answer: c

Q2. Maximum current of solar cell occurs at:

- a) Open-circuit
- b) Short-circuit
- c) Maximum power point.
- d) Zero irradiance

Answer: b

Q3. Power extracted from a wind turbine is proportional to:

- a) Wind speed
- b) Wind speed squared
- c) Wind speed cubed
- d) Wind speed inverse

Answer: c

Q4. Horizontal axis wind turbines are preferred for:

- a) Small-scale urban use
- b) Large-scale power generation
- c) Roof-mounted systems
- d) Indoor applications

Answer: b

Q5. Fuel cells convert energy:

- a) Thermal → Mechanical
- b) Chemical → Electrical
- c) Solar → Electrical
- d) Mechanical → Electrical

Answer: b

Q6. PEM fuel cell is commonly used in:

- a) Power plants
- b) Vehicles
- c) Grid-scale plants
- d) Boilers

Answer: b

Q7. Tidal energy is considered:

- a) Non-renewable
- b) Renewable and predictable

c) Intermittent and unpredictable

d) Fossil fuel based

Answer: b

Q8. Biomass energy can be produced by:

- a) Combustion
- b) Anaerobic digestion
- c) Gasification
- d) All of the above

Answer: d

Q9. Main advantage of HVDC over HVAC for long distances is:

- a) Higher cost
- b) Lower losses
- c) Voltage drops faster
- d) Requires more reactive power

Answer: b

Q10. VSC-based HVDC uses:

- a) Thyristors only
- b) IGBTs
- c) Diodes
- d) Relays

Answer: b

Q11. SVC is used for:

- a) Real power control
- b) Voltage control by reactive power injection
- c) Load factor improvement
- d) Thermal management

Answer: b

Q12. STATCOM is:

- a) Series device
- b) Shunt device
- c) DC converter
- d) HVDC station

Answer: b

Q13. TCSC is a:

- a) Shunt device
- b) Series device controlling line reactance
- c) Voltage regulator
- d) Generator protection

Answer: b

Q14. UPFC can control:

- a) Real power only      b) Reactive power only
- c) Both real and reactive power
- d) Voltage only

Answer: c

Q15. FACTS devices mainly improve:

- a) Fuel efficiency
- b) Power system stability & controllability
- c) Load factor
- d) Transformer efficiency

Answer: b

## Analog Electronics

### PN Junction Diode

- Barrier Potential: Built-in voltage across PN junction (~0.7 V for Si, 0.3 V for Ge).
- I-V Characteristics:
  - Forward biased → current increases exponentially after threshold.
  - Reverse biased → small leakage current, breakdown at high voltage (Zener/avalanche).
- Rectifiers:
  - Half-wave: Conducts one half-cycle, efficiency ~40.6%, high ripple.
  - Full-wave: Conducts both half-cycles, efficiency ~81.2%, lower ripple.
  - Ripple Factor (r): Measure of AC content in output; lower is better.
- Zener Diode:
  - Operates in reverse breakdown region.
  - Used as voltage regulator: maintains constant voltage across load.

### ◆ Bipolar Junction Transistor (BJT)

- Configurations:
  1. CE (Common Emitter): High voltage & current gain; inverting amplifier.
  2. CB (Common Base): Low input, high voltage gain; non-inverting.
- Current Gain:
  - $\alpha = I_C/I_E$  (common base)
  - $\beta = I_C/I_B$  (common emitter) →  $\beta = \alpha/(1-\alpha)$
- Biasing Basics:
  - Ensures transistor remains in active region for amplification.
  - Common methods: Fixed bias, Voltage-divider bias.
- Amplifier Action:
  - Input small signal → output amplified (voltage/current/power).

#### ◆ MOSFET & CMOS

- MOSFET: Voltage-controlled device, high input impedance, unipolar conduction (n-channel/p-channel).
- CMOS Inverter: Complementary MOS (nMOS + pMOS), low static power dissipation, logic inverter.

#### ◆ Operational Amplifier (Op-Amp)

- Ideal Properties: Infinite gain, infinite input impedance, zero output impedance, zero offset voltage.
- Configurations:
  1. Inverting: Output  $180^\circ$  out of phase, gain =  $-R_f/R_{in}$
  2. Non-inverting: Output in phase, gain =  $1 + R_f/R_{in}$
  3. Integrator: Output =  $\int V_{in} dt$
  4. Differentiator: Output =  $dV_{in}/dt$
- Filters:
  - Low-pass, High-pass, Band-pass using Op-Amps.

#### ◆ Oscillators

- Barkhausen Criterion: Loop gain  $\geq 1$ , total phase shift =  $0^\circ$  or  $360^\circ$  for sustained oscillation.
- Wein Bridge Oscillator: RC network, low distortion sine wave.
- Colpitts Oscillator: LC tank with capacitive feedback.
- Hartley Oscillator: LC tank with inductive feedback.
- Crystal Oscillator: Uses piezoelectric crystal  $\rightarrow$  highly stable frequency.

#### ◆ Power Amplifiers

- Class A: Conduction angle  $360^\circ$ , low efficiency ( $\sim 20\text{--}30\%$ ), linear.
- Class B: Conduction  $180^\circ$ , efficiency  $\sim 70\%$ , crossover distortion.
- Class AB: Conduction  $180\text{--}360^\circ$ , compromise between A & B.
- Push-pull: Two devices amplify alternate halves  $\rightarrow$  reduces distortion, increases efficiency.

## PN Junction & Zener Diode

Q1. Barrier potential of Si diode is:

- a) 0.3 V                      b) 0.7 V  
c) 1.2 V                      d) 0.1 V

Answer: b

Q2. Forward biased diode current:

- a) Linear  
b) Exponential after threshold  
c) Constant  
d) Zero

Answer: b

Q3. Half-wave rectifier efficiency:

- a) 81.2%                      b) 50%  
c) 40.6%                      d) 90%

Answer: c

Q4. Ripple factor of full-wave rectifier:

- a) 1.21                      b) 0.482  
c) 0.693                      d) 0.5

Answer: b

Q5. Zener diode regulates voltage in:

- a) Forward bias              b) Reverse breakdown  
c) Avalanche only          d) Zero bias

Answer: b

## BJT & Amplifiers

Q6. CE configuration provides:

- a) Low gain  
b) High current & voltage gain  
c) No amplification  
d) Only current gain

Answer: b

Q7. CB configuration is:

- a) High input resistance  
b) Low input, high voltage gain  
c) Inverting only  
d) Push-pull

Answer: b

Q8.  $\beta = 49$ , then  $\alpha = ?$

- a) 0.95                      b) 0.98  
c) 0.99                      d) 0.90

Answer: b

Explanation:  $\alpha = \beta/(\beta+1) = 49/50 = 0.98$

Q9. Voltage-divider bias ensures:

- a) Temperature stability  
b) Maximum gain only  
c) Power factor improvement  
d) Rectification

Answer: a

Q10. In CE amplifier, output is:

- a) In phase                      b) 180° out of phase  
c) 90° out of phase          d) Zero

Answer: b

## MOSFET & CMOS

Q11. MOSFET is:

- a) Current-controlled      b) Voltage-controlled  
c) Hybrid                      d) Relay

Answer: b

Q12. CMOS inverter uses:

- a) Only nMOS                      b) Only pMOS  
c) Both nMOS + pMOS      d) Bipolar transistor

Answer: c

Q13. Advantage of CMOS inverter:

- a) High static power  
b) Low static power dissipation  
c) Medium gain  
d) Only digital input

Answer: b

## Op-Amp

Q14. Ideal input impedance of op-amp:

- a) Zero                      b) Infinite  
c) 1 k $\Omega$                       d) 10  $\Omega$

Answer: b

Q15. Inverting amplifier gain:

- a)  $R_f/R_{in}$                       b)  $-R_f/R_{in}$   
c)  $R_{in}/R_f$                       d)  $1+R_f/R_{in}$

Answer: b

Q16. Non-inverting amplifier gain:

- a)  $1+R_f/R_{in}$                       b)  $-R_f/R_{in}$   
c)  $R_f/R_{in}$                       d)  $R_{in}/R_f$

Answer: a

Q17. Integrator output  $\propto$ :

- a)  $V_{in}$                       b)  $-\int V_{in} dt$   
c)  $dV_{in}/dt$                       d)  $V_{in}^2$

Answer: b

Q18. Differentiator output:

- a)  $V_{in}$                       b)  $-\int V_{in} dt$   
c)  $dV_{in}/dt$                       d)  $V_{in}^2$

Answer: c

### Oscillators

Q19. Barkhausen criterion for oscillation:

- a) Loop gain  $<1$   
b) Loop gain  $\geq 1$  & phase shift  $0^\circ$  or  $360^\circ$   
c) Only high voltage  
d) None

Answer: b

Q20. Wein bridge oscillator uses:

- a) LC tank                      b) RC network  
c) Transformer                      d) Diode

Answer: b

Q21. Colpitts oscillator uses:

- a) Capacitive feedback LC  
b) RC network  
c) Crystal  
d) Transformer feedback

Answer: a

Q22. Hartley oscillator feedback:

- a) Inductive                      b) Capacitive  
c) RC only                      d) None

Answer: a

Q23. Crystal oscillator provides:

- a) Variable frequency  
b) Highly stable frequency  
c) Low power only  
d) AC-DC conversion

Answer: b

### Power Amplifiers

Q24. Class A amplifier conduction angle:

- a)  $180^\circ$                       b)  $360^\circ$   
c)  $90^\circ$                       d)  $270^\circ$

Answer: b

Q25. Class B amplifier conduction:

- a)  $360^\circ$                       b)  $180^\circ$   
c)  $90^\circ$                       d)  $270^\circ$

Answer: b

Q26. Efficiency of Class A:

- a) 20-30%                      b) 70%  
c) 90%                      d) 50%

Answer: a

Q27. Push-pull amplifier reduces:

- a) Gain                      b) Distortion  
c) Input impedance                      d) Output voltage

Answer: b

Q28. Class AB amplifier conduction angle:

- a)  $180-360^\circ$                       b)  $90^\circ$   
c)  $360^\circ$                       d)  $180^\circ$  only

Answer: a

Q29. Main advantage of Class B:

- a) Linear output                      b) High efficiency  
c) No distortion                      d) Low gain

Answer: b

Q30. Push-pull Class B uses:

- a) Single transistor
- b) Two transistors conducting alternate half-cycles
- c) Op-amp
- d) MOSFET inverter

Answer: b

### Mixed Revision

Q31. Reverse saturation current in diode:

- a) Depends on temperature
- b) Constant always
- c) Zero
- d) Depends on AC voltage

Answer: a

Q32. CE  $\beta$  is:

- a)  $I_C/I_B$
- b)  $I_E/I_C$
- c)  $I_B/I_C$
- d)  $I_C/I_E$

Answer: a

Q33. Output of inverting op-amp:

- a) In phase
- b)  $180^\circ$  out of phase
- c)  $90^\circ$  out of phase
- d) Zero

Answer: b

Q34. CMOS logic inverter consumes power:

- a) Constant
- b) Only during switching
- c) Never
- d) Only in forward bias

Answer: b

Q35. Zener voltage remains constant if:

- a) Current small or large
- b) Current within regulation range
- c) Only in forward bias
- d) AC applied

Answer: b

Q36. MOSFET has:

- a) Bipolar conduction
- b) Unipolar conduction
- c) Only P-channel
- d) Only N-channel

Answer: b

Q37. Differentiator op-amp output:

- a) Integral
- b) Derivative
- c) Constant
- d) Zero

Answer: b

Q38. Class A amplifier linearity:

- a) Poor
- b) Excellent
- c) Medium
- d) Zero

Answer: b

Q39. Hartley oscillator tank circuit:

- a) RC
- b) LC with tapped inductor
- c) Only capacitor
- d) Only resistor

Answer: b

Q40. Full-wave rectifier ripple factor:

- a) 0.482
- b) 1
- c) 0.693
- d) 0.5

Answer: a

### Power electronics

| Device                                   | Type                    | Key Features                                | Applications                           |
|------------------------------------------|-------------------------|---------------------------------------------|----------------------------------------|
| SCR (Silicon Controlled Rectifier)       | Thyristor               | Latching device, controlled in forward bias | Controlled rectifiers, inverters       |
| TRIAC                                    | Bidirectional Thyristor | Conducts in both directions                 | AC control, dimmers, speed control     |
| IGBT (Insulated Gate Bipolar Transistor) | MOS-gated               | High voltage & current, fast switching      | Inverters, UPS, motor drives           |
| MOSFET                                   | Voltage-controlled      | Fast switching, high frequency              | DC-DC converters, SMPS                 |
| UJT (Unijunction Transistor)             | Switching device        | Negative resistance, triggers SCR           | Relaxation oscillator, pulse generator |

#### Rectifiers

- Half-wave: Conducts only one half-cycle.
- Full-wave: Conducts both half-cycles → higher efficiency.
- Controlled: Uses SCRs → output voltage controlled.
- Uncontrolled: Uses diodes → fixed output voltage.

#### Efficiency:

- Half-wave  $\approx 40.6\%$
- Full-wave  $\approx 81.2\%$

| Class                                                                   | Conduction Angle | Efficiency |
|-------------------------------------------------------------------------|------------------|------------|
| Class A                                                                 | 360°             | ~20-30%    |
| Class B                                                                 | 180°             | ~70%       |
| Note: Push-pull Class B → reduces distortion, maintains ~70% efficiency |                  |            |

Q1. SCR is:

- a) Voltage-controlled device
- b) Latching thyristor, controlled in forward bias
- c) Bidirectional switch
- d) High-frequency MOSFET

Answer: b

Q2. TRIAC conducts:

- a) Only in forward bias
- b) Both directions when gate triggered
- c) Only in reverse bias
- d) Only for DC

Answer: b

Q3. IGBT combines:

- a) High current of BJT + voltage control of MOSFET
- b) Low power MOSFET only
- c) Triac + diode
- d) SCR + diode

Answer: a

Q4. UJT is mainly used for:

- a) Rectification
- b) Triggering SCR
- c) Voltage regulation
- d) High power amplification

Answer: b

Q5. MOSFET is:

- a) Current-controlled
- b) Voltage-controlled
- c) Bi-directional current device
- d) Passive

Answer: b

### Rectifiers

Q6. Full-wave rectifier efficiency:

- a) 40.6%
- b) 81.2%
- c) 50%
- d) 70%

Answer: b

Q7. Controlled rectifier uses:

- a) Diode
- b) SCR
- c) MOSFET only
- d) TRIAC

Answer: b

Q8. Uncontrolled rectifier uses:

- a) SCR
- b) Diode
- c) TRIAC
- d) IGBT

Answer: b

Q9. Half-wave rectifier conducts:

- a) One half-cycle
- b) Both half-cycles
- c) Only positive cycles
- d) Only negative cycles

Answer: a

Q10. Ripple factor decreases when:

- a) Using half-wave rectifier
- b) Using full-wave rectifier
- c) Input AC frequency decreases
- d) No capacitor used

Answer: b

### DC-DC Converters

Q11. Buck converter output:

- a)  $V_{out} > V_{in}$
- b)  $V_{out} < V_{in}$
- c)  $V_{out} = V_{in}$  always
- d) Alternating output

Answer: b

Q12. Boost converter output:

- a)  $V_{out} < V_{in}$
- b)  $V_{out} > V_{in}$
- c) Same as input
- d) Bidirectional

Answer: b

Q13. Buck-Boost converter:

- a) Step-down only
- b) Step-up only
- c) Step-up or step-down with polarity inversion
- d) AC to DC conversion

Answer: c

Q14. Buck converter is used for:

- a) Battery charging    b) Step-up voltage  
c) AC regulation    d) High-frequency AC

Answer: a

Q15. Boost converter is used for:

- a) Step-down voltage  
b) Step-up voltage  
c) Step-down current only  
d) Rectification

Answer: b

### Power Amplifiers Efficiency

Q16. Class A amplifier efficiency:

- a) 70%    b) 20-30%  
c) 50%    d) 90%

Answer: b

Q17. Class B amplifier conduction angle:

- a) 360°    b) 180°  
c) 90°    d) 270°

Answer: b

Q18. Push-pull Class B reduces:

- a) Gain    b) Distortion  
c) Voltage    d) Current

Answer: b

Q19. Class AB amplifier conduction:

- a) 360°    b) 180-360°  
c) 90°    d) 180° only

Answer: b

Q20. Main advantage of Class B over Class A:

- a) Better linearity    b) Higher efficiency  
c) Less conduction angle.    d) Simpler design

Answer: b

### Logic Gates

| input |   | output |    |      |     |     |      |  |
|-------|---|--------|----|------|-----|-----|------|--|
| A     | B | AND    | OR | NAND | NOR | XOR | XNOR |  |
| 0     | 0 | 0      | 0  | 1    | 1   | 0   | 1    |  |
| 0     | 1 | 0      | 1  | 1    | 0   | 1   | 0    |  |
| 1     | 0 | 0      | 1  | 1    | 0   | 1   | 0    |  |
| 1     | 1 | 1      | 1  | 0    | 0   | 0   | 1    |  |

### Flip flops

| Type | Inputs | Operation             | Notes                     |
|------|--------|-----------------------|---------------------------|
| SR   | S,R    | Set/Reset             | Invalid when S=R=1        |
| JK   | J,K    | Toggle on J=K=1       | Resolves SR invalid state |
| D    | D      | Stores input on clock | Data latch                |
| T    | T      | Toggles output on T=1 | Simplifies counters       |

## Counters

- Ripple Counter (Asynchronous): Output of one flip-flop triggers next → propagation delay.
- Synchronous Counter: All flip-flops triggered simultaneously → faster, no ripple.
- Johnson Counter: Ring counter with inverted feedback →  $2n$  states with  $n$  flip-flops.
- Ring Counter: Single 1 circulating through flip-flops →  $n$  states with  $n$  flip-flops.

## ◆ ADC/DAC

ADC (Analog → Digital):

1. R-2R Ladder: Resistor network → binary-weighted voltage → low cost.
2. Flash ADC: Parallel comparators → very fast, expensive.
3. SAR ADC (Successive Approximation): Iterative approach → medium speed, accurate.

DAC (Digital → Analog):

- Converts binary input to proportional analog voltage
- Uses weighted resistors or R-2R ladder

## Logic Gates & Boolean Algebra

Q1. Universal gates include:

- |               |               |
|---------------|---------------|
| a) AND & OR   | b) NAND & NOR |
| c) XOR & XNOR | d) NOT & OR   |

Answer: b

Q3. XOR gate output is 1 when:

- |                         |                   |
|-------------------------|-------------------|
| a) Both inputs 1        | b) Both inputs 0  |
| c) Inputs are different | d) Either input 0 |

Answer: c

Q4. Logic gate used for inversion:

- |        |        |
|--------|--------|
| a) AND | b) OR  |
| c) NOT | d) XOR |

Answer: c

Q5. NAND gate can implement:

- |                      |                       |
|----------------------|-----------------------|
| a) Only AND function | b) Any logic function |
| c) Only OR function  | d) None               |

Answer: b

Q6. K-map simplification reduces:

- |                      |                          |
|----------------------|--------------------------|
| a) Power             | b) Number of logic gates |
| c) Propagation delay | d) Only inputs           |

Answer: b

Q7. Boolean identity:  $A + 0 = ?$

- |      |             |
|------|-------------|
| a) 0 | b) A        |
| c) 1 | d) $\neg A$ |

Answer: b

Q8. Boolean complement:  $A \cdot \neg A = ?$

- |      |             |
|------|-------------|
| a) 1 | b) 0        |
| c) A | d) $\neg A$ |

Answer: b

Q9. OR gate output for  $A=0, B=1$ :

- |            |      |
|------------|------|
| a) 0       | b) 1 |
| c) Depends | d) 2 |

Answer: b

### Flip-Flops

Q11. SR flip-flop invalid state:

- a)  $S=R=0$                       b)  $S=R=1$   
c)  $S=1, R=0$                       d)  $S=0, R=1$

Answer: b

Q12. JK flip-flop toggles when:

- a)  $J=K=0$                       b)  $J=K=1$   
c)  $J=0, K=1$                       d)  $J=1, K=0$

Answer: b

Q13. D flip-flop stores:

- a) Complement of D      b) Input D at clock edge  
c) Toggle input              d) Random data

Answer: b

Q14. T flip-flop toggles output when:

- a)  $T=0$                       b)  $T=1$   
c) Clock=0                      d) Input=0

Answer: b

Q15. Flip-flops are:

- a) Memory elements              b) Oscillators  
c) Rectifiers                      d) Amplifiers

Answer: a

### Counters

Q16. Ripple counter is:

- a) Synchronous                      b) Asynchronous  
c) Johnson                      d) Ring

Answer: b

Q17. Synchronous counter solves:

- a) Toggle problem  
b) Propagation delay of ripple counter  
c) Output voltage  
d) Input impedance

Answer: b

Q18. Johnson counter with n flip-flops has:

- a) n states                      b)  $2n$  states  
c)  $n/2$  states                      d)  $4n$  states

Answer: b

Q19. Ring counter states = ?

- a) n                      b)  $2n$   
c)  $n^2$                       d)  $2^n$

Answer: a

Q20. Ring counter requires:

- a) n flip-flops for n states.      b)  $2n$  flip-flops  
c)  $n/2$  flip-flops                      d) Only 1 flip-flop

Answer: a

### ADC/DAC

Q21. R-2R ladder DAC uses:

- a) Capacitors only  
b) Resistors in binary-weighted network  
c) Transistors  
d) Diodes

Answer: b

Q22. Flash ADC is:

- a) Slow, low cost                      b) Fast, expensive  
c) Medium speed                      d) DC only

Answer: b

Q23. SAR ADC uses:

- a) Parallel comparison  
b) Successive approximation  
c) Flash technique  
d) Delta modulation

Answer: b

Q24. DAC converts:

- a) Digital  $\rightarrow$  Analog                      b) Analog  $\rightarrow$  Digital  
c) DC  $\rightarrow$  AC                      d) AC  $\rightarrow$  DC

Answer: a

Q25. ADC converts:

- a) Digital  $\rightarrow$  Analog                      b) Analog  $\rightarrow$  Digital  
c) AC  $\rightarrow$  DC                      d) DC  $\rightarrow$  AC

Answer: b

Q26. Flash ADC advantage:

- a) High speed  
b) Low cost

c) Low resolution

d) Requires few comparators

Answer: a

Q27. R-2R ladder DAC advantage:

a) Few resistors, simple.    b) High cost

c) High frequency only    d) Flash operation

Answer: a

Q28. SAR ADC is suitable for:

a) High speed only

b) Medium speed & accurate

c) Low accuracy only

d) AC measurement

Answer: b

Q29. ADC resolution depends on:

a) Number of comparators / bits

b) Input voltage only

c) Output load

d) Clock frequency

Answer: a

Q30. DAC output voltage is:

a) Discrete                      b) Analog

c) Digital                        d) Constant

Answer: b

Mixed Revision

Q31. NAND gate output for A=1,B=1:

a) 1                                b) 0

c) Depends                      d) None

Answer: b

Q32. NOR gate output for A=0,B=0:

a) 0                                b) 1

c) 2                                d) Depends

Answer: b

Q33. K-map used for:

a) Amplifier design    b) Logic simplification

c) Rectification            d) Oscillation

Answer: b

Q34. Flip-flop triggered on:

a) Clock edge

b) Input only

c) Output only

d) Power supply

Answer: a

Q35. Ripple counter speed:

a) Fast

b) Slow (propagation delay)

c) Medium

d) Instant

Answer: b

Q36. ADC/DAC commonly used in:

a) Digital communication

b) Power transmission

c) Transformers

d) Rectifiers

Answer: a

Q37. Johnson counter output pattern:

a) Circulating 1s

b) Complement circulating

c) Random

d) Always 0

Answer: b

Q38. Ring counter initial state:

a) Single 1 in flip-flops

b) All 1s

c) Alternating 1s & 0s

d) Depends

Answer: a

Q39. Digital logic simplification reduces:

a) Power & cost

b) Voltage

c) Frequency

d) Temperature

Answer: a

Q40. DAC output smoothness improves with:

a) More bits

b) Fewer bits

c) Higher input voltage only

d) Lower input voltage only

Answer: a

### Communication Engineering

| Modulation                | Key Concept                          | Bandwidth                          | Notes                             |
|---------------------------|--------------------------------------|------------------------------------|-----------------------------------|
| AM (Amplitude Modulation) | Signal amplitude varies with message | $2 \times f_m$ (message bandwidth) | Simple, sensitive to noise        |
| FM (Frequency Modulation) | Frequency varies with message        | $2(\Delta f + f_m)$                | More noise immunity, wider BW     |
| PM (Phase Modulation)     | Phase varies with message            | Similar to FM                      | Used in digital comm. & satellite |

### Demodulation Methods:

- AM  $\rightarrow$  Envelope detector
- FM  $\rightarrow$  Frequency discriminator, Phase-locked loop (PLL)
- PM  $\rightarrow$  PLL or coherent detection

### Sampling Theorem

- Definition: Continuous signal can be reconstructed from samples if sampling frequency  $f_s \geq 2 \times f_{max}$
- Nyquist Rate:  $2 \times f_{max}$
- Aliasing: Occurs if  $f_s < 2 \times f_{max} \rightarrow$  distortion

| Method                      | Description                                                              | Notes                         |
|-----------------------------|--------------------------------------------------------------------------|-------------------------------|
| PCM (Pulse Code Modulation) | Analog $\rightarrow$ sampled $\rightarrow$ quantized $\rightarrow$ coded | Standard digital transmission |
| Delta Modulation (DM)       | Tracks signal with 1-bit difference                                      | Simple, low BW                |
| DPCM (Differential PCM)     | Encodes difference between successive samples                            | Reduces redundancy            |
| ADPCM (Adaptive DPCM)       | Adaptive step size $\rightarrow$ better fidelity                         | Used in speech coding         |

| Scheme                       | Key Feature                       | Bandwidth / Noise Immunity          | Notes                        |
|------------------------------|-----------------------------------|-------------------------------------|------------------------------|
| ASK (Amplitude Shift Keying) | Amplitude varies                  | Low BW, sensitive to noise          | Simple, poor noise immunity  |
| FSK (Frequency Shift Keying) | Frequency varies                  | Medium BW, good noise immunity      | Used in modems               |
| PSK (Phase Shift Keying)     | Phase varies                      | Efficient BW, better noise immunity | Coherent detection           |
| QPSK (Quadrature PSK)        | 2 bits/symbol → doubles data rate | Efficient BW                        | Widely used in digital comm. |
| MSK (Minimum Shift Keying)   | Continuous phase FSK variant      | Narrow BW, high efficiency          | Good spectral efficiency     |

| Type                                   | Concept                                             | Notes           |
|----------------------------------------|-----------------------------------------------------|-----------------|
| TDM (Time Division Multiplexing)       | Different signals share time slots                  | Digital systems |
| FDM (Frequency Division Multiplexing)  | Different signals occupy different frequency bands  | Analog systems  |
| CDMA (Code Division Multiple Access)   | Different users share same BW with orthogonal codes | Cellular comm.  |
| WDM (Wavelength Division Multiplexing) | Different optical wavelengths                       | Fiber optics    |

Q1. AM signal varies in:

- a) Amplitude                      b) Frequency  
c) Phase                              d) Power

Answer: a

Q2. FM signal varies in:

- a) Amplitude                      b) Frequency  
c) Phase                              d) None

Answer: b

Q3. PM signal varies in:

- a) Amplitude                      b) Frequency  
c) Phase                              d) Power

Answer: c

Q4. AM bandwidth:

- a)  $f_m$                                   b)  $2 \times f_m$   
c)  $4 \times f_m$                           d)  $\Delta f + f_m$

Answer: b

Q5. FM is preferred over AM because:

- a) Simple                              b) Less noise immunity  
c) More noise immunity      d) Narrow BW

Answer: c

Q6. AM demodulation uses:

- a) PLL  
b) Envelope detector

- c) Frequency discriminator  
d) Coherent detection

Answer: b

Q7. FM demodulation uses:

- a) Envelope detector  
b) Frequency discriminator  
c) Rectifier  
d) Delta modulation

Answer: b

Q8. PM demodulation often uses:

- a) PLL  
b) Envelope detector  
c) Delta modulator  
d) None

Answer: a

Q9. Noise immunity order:

- a) AM > FM > PM  
b) FM > PM > AM  
c) PM  $\approx$  FM > AM  
d) AM  $\approx$  FM > PM

Answer: c

Q10.  $\Delta f$  in FM represents:

- a) Carrier amplitude  
b) Frequency deviation  
c) Phase shift  
d) Message signal

Answer: b

### Sampling Theorem & Aliasing

Q11. Nyquist rate = ?

- a)  $f_{max}$   
b)  $2 \times f_{max}$   
c)  $f_{max}/2$   
d)  $f_s/2$

Answer: b

Q12. Aliasing occurs when:

- a)  $f_s > 2 \times f_{max}$   
b)  $f_s < 2 \times f_{max}$   
c)  $f_s = 2 \times f_{max}$   
d)  $f_s = f_{max}$

Answer: b

Q13. Sampling theorem ensures:

- a) Perfect reconstruction if  $f_s \geq 2 \times f_{max}$   
b) Partial reconstruction  
c) Aliasing  
d) None

Answer: a

Q14. Sampled signal can be reconstructed using:

- a) RC filter  
b) Low-pass filter  
c) High-pass filter  
d) Band-pass filter

Answer: b

Q15. Nyquist frequency =

- a)  $f_{max}$   
b)  $f_s$   
c)  $f_s/2$   
d)  $2f_s$

Answer: c

PCM & Variants

Q16. PCM converts:

- a) Analog  $\rightarrow$  Digital  
b) Digital  $\rightarrow$  Analog  
c) AC  $\rightarrow$  DC  
d) Frequency  $\rightarrow$  Phase

Answer: a

Q17. Delta modulation step size:

- a) Fixed  
b) Adaptive  
c) Random  
d) None

Answer: a

Q18. DPCM encodes:

- a) Absolute sample value  
b) Difference between samples  
c) Phase only  
d) Frequency only

Answer: b

Q19. ADPCM improves over DPCM by:

- a) Fixed step size  
b) Adaptive step size  
c) No coding  
d) Only analog

Answer: b

Q20. PCM main advantage:

- a) Noise immunity  
b) Low bandwidth  
c) Analog fidelity  
d) Simple hardware

Answer: a

### Digital Modulation

Q21. ASK varies:

- a) Amplitude  
b) Frequency  
c) Phase  
d) Both

Answer: a

Q22. FSK varies:

- a) Amplitude                      b) Frequency
- c) Phase                              d) Time

Answer: b

Q23. PSK varies:

- a) Amplitude                      b) Frequency
- c) Phase                              d) Voltage

Answer: c

Q24. QPSK transmits:

- a) 1 bit/symbol                      b) 2 bits/symbol
- c) 4 bits/symbol                      d) 8 bits/symbol

Answer: b

Q25. MSK is:

- a) High BW variant of ASK
- b) Continuous phase FSK
- c) PSK variant
- d) PCM type

Answer: b

Q26. Noise immunity:

- a) ASK > FSK > PSK              b) PSK > FSK > ASK
- c) FSK > ASK > PSK              d) ASK > PSK > FSK

Answer: b

Q27. Bandwidth efficiency:

- a) MSK > QPSK                      b) QPSK > MSK
- c) ASK > PSK                              d) FSK > ASK

Answer: b

Q28. Coherent detection is used for:

- a) ASK                                      b) FSK
- c) PSK                                      d) Delta modulation

Answer: c

Q29. Digital modulation reduces:

- a) BW only                              b) Noise
- c) Signal amplitude                      d) All analog properties

Answer: b

Q30. Binary FSK uses:

- a) Two frequencies                      b) Two amplitudes
- c) Two phases                              d) None

Answer: a

### Multiplexing

Q31. TDM is:

- a) Frequency-based                      b) Time-based
- c) Code-based                              d) Wavelength-based

Answer: b

Q32. FDM is:

- a) Time-based                              b) Frequency-based
- c) Code-based                              d) Wavelength-based

Answer: b

Q33. CDMA uses:

- a) Frequency division                      b) Code division
- c) Time division                              d) Wavelength division

Answer: b

Q34. WDM is used in:

- a) Wireless comm                      b) Fiber optic
- c) Analog TV                              d) Delta modulation

Answer: b

Q35. Multiplexing reduces:

- a) Channel efficiency                      b) Cost & channel usage
- c) Signal strength                              d) Noise immunity

Answer: b

Q36. In TDM, each user occupies:

- a) Entire bandwidth                      b) Time slot
- c) Frequency slot                              d) Code only

Answer: b

Q37. In FDM, signals are separated by:

- a) Time                                      b) Frequency
- c) Code                                      d) Voltage

Answer: b

Q38. CDMA uses:

- a) Orthogonal codes                      b) Frequency bands
- c) Time slots                              d) Voltage levels

Answer: a

Q39. Nyquist rate ensures:

- a) Minimum BW
- b) Accurate reconstruction
- c) Multiplexing
- d) Analog amplitude only

Answer: b

Q40. Flash ADC is:

- a) Slow & cheap
- b) Fast & expensive
- c) Medium speed
- d) Low accuracy

Answer: b

### Routh-Hurwitz Stability Criterion

- Determines stability of linear time-invariant (LTI) systems without computing roots explicitly.
- Procedure:
  1. Form Routh array using characteristic equation coefficients.
  2. Count sign changes in the first column → number of roots with positive real part.
- Stable System: No sign changes → all poles in LHP.
- Marginally Stable: Zero in first column → special case handled with auxiliary polynomial.

### ◆ Block Diagram Reduction & Transfer Function

- Transfer Function (TF): Ratio of Laplace output to input, assuming zero initial conditions.
- Block Diagram Simplification Rules:
  1. Series blocks: Multiply TFs
  2. Parallel blocks: Add/subtract TFs
- Purpose: Obtain overall transfer function → analyze stability & response.

### ◆ Root Locus Basics

- Definition: Locus of closed-loop poles as system gain  $K$  varies from  $0 \rightarrow \infty$ .
- Key Points:
  1. Starts at open-loop poles → ends at open-loop zeros
  2. Symmetric about real axis
  3. Number of branches = number of open-loop poles
- Interpretation: Shows how system poles move, predicting stability & transient response.

### ◆ Steady-State Error Constants

- Error constants for unity-feedback systems:
  - Position constant ( $K_p$ ): For step input  $\rightarrow ess = 1/(1+K_p)$
  - Velocity constant ( $K_v$ ): For ramp input  $\rightarrow ess = 1/K_v$
  - Acceleration constant ( $K_a$ ): For parabolic input  $\rightarrow ess = 1/K_a$
- Ess (steady-state error) depends on system type (number of integrators in open-loop TF).

### ◆ PID Controller Basics

- PID = Proportional + Integral + Derivative
- Effect:
  - P: Reduces rise time, may increase overshoot
  - I: Eliminates steady-state error
  - D: Reduces overshoot, improves stability
- Application: Closed-loop control  $\rightarrow$  speed, position, temperature control

### Routh-Hurwitz Stability

Q1. Routh-Hurwitz criterion determines:

- Time response
- Stability without solving roots
- Steady-state error
- Open-loop gain

Answer: b

Q2. Stable system  $\rightarrow$  sign changes in first column:

- Zero
- One
- Two
- Any

Answer: a

Q3. Number of poles in RHP equals:

- Sign changes in first column
- Number of zeros
- Number of feedback loops
- $K_p$  value

Answer: a

Q4. Marginal stability occurs if:

- All poles in LHP
- Poles on  $j\omega$  axis
- Poles in RHP
- No poles

Answer: b

Q5. Routh array helps find:

- TF
- Pole locations
- Number of unstable poles
- Error constants

Answer: c

### Block Diagram & Transfer Function

Q6. Series TF:

- Add
- Multiply
- Divide
- Subtract

Answer: b

Q7. Parallel TF:

- Multiply
- Add/Subtract
- Divide
- None

Answer: b

Q8. Feedback TF:

- a)  $G(s)H(s)$                       b)  $G(s)/(1+G(s)H(s))$   
c)  $1/G(s)$                         d)  $H(s)/(1+G(s))$

Answer: b

Q9. Purpose of block diagram reduction:

- a) Analyze open-loop only  
b) Obtain overall TF for analysis  
c) Eliminate feedback  
d) Compute  $K_p$

Answer: b

Q10. Unity feedback  $\rightarrow$  Closed-loop TF:

- a)  $G(s)$                               b)  $G(s)/(1+G(s))$   
c)  $1/(1+G(s))$                       d)  $G(s)H(s)$

Answer: b

### Root Locus

Q11. Root locus shows:

- a) Steady-state error  
b) Pole movement as  $K$  varies  
c) Zeros only  
d) Input signal

Answer: b

Q12. Root locus branches start at:

- a) Closed-loop poles      b) Open-loop poles  
c) Zeros                      d) Gain  $K$

Answer: b

Q13. Symmetry of root locus:

- a) Real axis                      b) Imag axis  
c) Both axes                      d) None

Answer: a

Q14. Number of root locus branches =

- a) Number of open-loop poles  
b) Number of zeros  
c) Number of feedback loops  
d) Number of integrators

Answer: a

Q15. Root locus helps in:

- a) Steady-state error  
b) Stability & transient response prediction  
c) Block diagram simplification  
d)  $K_p$  calculation

Answer: b

### Steady-State Error & PID

Q16. Steady-state error for step input depends on:

- a)  $K_p$                               b)  $K_v$   
c)  $K_a$                               d)  $K_d$

Answer: a

Q17. Ramp input error depends on:

- a)  $K_p$                               b)  $K_v$   
c)  $K_a$                               d)  $K_d$

Answer: b

Q18. Integral action in PID:

- a) Reduces rise time  
b) Eliminates steady-state error  
c) Reduces overshoot  
d) Increases gain

Answer: b

Q19. Derivative action in PID:

- a) Eliminates steady-state error  
b) Reduces overshoot  
c) Increases rise time  
d) None

Answer: b

Q20. Proportional action mainly:

- a) Reduces steady-state error  
b) Reduces rise time, may increase overshoot  
c) Reduces overshoot  
d) Improves stability only

Answer: b

### Microprocessor (8086)

| Feature     | Microprocessor             | Microcontroller                |
|-------------|----------------------------|--------------------------------|
| CPU         | Only CPU                   | CPU + RAM + ROM + I/O + timers |
| Application | PCs, servers               | Embedded systems, appliances   |
| Cost        | Higher                     | Low                            |
| Complexity  | High                       | Moderate                       |
| Integration | Needs external peripherals | Integrated                     |
| Example     | Intel 8086, 8088           | 8051, PIC, ARM Cortex-M        |

### 8086 Microprocessor Architecture

- Registers:

| Type                | Registers                          | Use                             |
|---------------------|------------------------------------|---------------------------------|
| General Purpose     | AX, BX, CX, DX                     | Data manipulation, arithmetic   |
| Segment             | CS, DS, SS, ES                     | Memory addressing               |
| Pointer/Index       | SP, BP, SI, DI                     | Stack, array, memory operations |
| Instruction Pointer | IP                                 | Address of next instruction     |
| Flags               | CF, PF, AF, ZF, SF, TF, IF, DF, OF | Status & control                |

Physical Address = segment \* 16 + offset

### Instruction Format & Addressing Modes

- Instruction Format:
  - Opcode + Operand(s)
  - Examples: MOV AX, BX, ADD AX, 10h
- Addressing Modes:
  - Immediate: Operand in instruction → MOV AX, 5
  - Register: Operand in register → MOV AX, BX
  - Direct: Memory address specified → MOV AX, [2000h]
  - Indirect: Memory via register → MOV AX, [BX]
  - Based/Indexed: Array access → MOV AX, [BX+SI]
  - Relative: For jumps → JMP LABEL

## ◆ Interrupts

- Hardware Interrupts: Triggered by external devices → INT pin
- Software Interrupts: Triggered by INT instruction → used in BIOS & DOS calls
- 8259 PIC (Programmable Interrupt Controller):
  - Manages multiple interrupts
  - Maps them to CPU vectors
  - Supports priority levels

### Microprocessor vs Microcontroller

Q1. A microcontroller differs from a microprocessor in that it:

- a) Has no CPU
- b) Integrates CPU + peripherals
- c) Needs external RAM
- d) Is only used in PCs

Answer: b

Q2. Microprocessor is mainly used in:

- a) Embedded systems
- b) PC & servers
- c) Microwave ovens
- d) Traffic lights

Answer: b

Q3. Microcontroller example:

- a) 8086
- b) 8051
- c) Pentium
- d) 8088

Answer: b

Q4. Microprocessor cost:

- a) Low
- b) High
- c) Same as microcontroller
- d) None

Answer: b

Q5. Microcontroller is suitable for:

- a) General computing
- b) Embedded control
- c) Servers
- d) PCs

Answer: b

### 8086 Architecture

Q6. Physical address = ?

- a) Segment + Offset
- b) Segment × 16 + Offset
- c) Segment × 8 + Offset
- d) Segment - Offset

Answer: b

Q7. General-purpose registers:

- a) AX, BX, CX, DX
- b) CS, DS, SS, ES
- c) SP, BP
- d) IP only

Answer: a

Q8. Stack pointer register:

- a) AX
- b) SP
- c) IP
- d) CS

Answer: b

Q9. Instruction pointer stores:

- a) Data
- b) Next instruction address
- c) Stack value
- d) Flag status

Answer: b

Q10. Flag register includes:

- a) CF, ZF, SF
- b) AX, BX, CX
- c) SP, BP
- d) IP only

Answer: a

### Instruction Format & Addressing Modes

Q11. Immediate addressing example:

- a) MOV AX, BX
- b) MOV AX, 5
- c) MOV AX, [2000h]
- d) JMP LABEL

Answer: b

Q12. Register addressing example:

- a) MOV AX, 5                      b) MOV AX, BX  
c) MOV AX, [2000h]            d) MOV AX, [BX+SI]

Answer: b

Q13. Direct addressing uses:

- a) Register  
b) Memory address explicitly  
c) Immediate data  
d) Stack pointer

Answer: b

Q14. Indirect addressing example:

- a) MOV AX, [BX]                  b) MOV AX, 5  
c) MOV AX, [2000h]            d) MOV AX, BX

Answer: a

Q15. Relative addressing used in:

- a) Data transfer                  b) Jumps  
c) Stack operations              d) Flag setting

Answer: b

### Interrupts & 8259 PIC

Q16. Hardware interrupt is triggered by:

- a) CPU instruction              b) External device  
c) Timer only                      d) Stack

Answer: b

Q17. Software interrupt is triggered by:

- a) External device              b) INT instruction  
c) Timer                              d) RAM

Answer: b

Q18. 8259 PIC manages:

- a) Data bus                          b) Multiple interrupts  
c) ALU operations              d) Stack

Answer: b

Q19. Interrupt vector points to:

- a) Memory location of service routine  
b) Data register

c) Stack pointer

d) ALU output

Answer: a

Q20. Interrupt priority in 8259 PIC:

- a) Highest assigned to lowest line  
b) Lowest assigned to highest line  
c) Random  
d) CPU decides

Answer: a

Miscellaneous 8086 MCQs

Q21. 8086 is a:

- a) 8-bit processor                  b) 16-bit processor  
c) 32-bit processor              d) Microcontroller

Answer: b

Q22. Segment registers include:

- a) AX, BX                              b) CS, DS, SS, ES  
c) SP, BP                              d) IP, FLAG

Answer: b

Q23. BX is:

- a) Base register                      b) Index register  
c) Pointer register                  d) Stack pointer

Answer: a

Q24. SI register stands for:

- a) Source index                      b) Stack input  
c) Segment input                  d) Status indicator

Answer: a

Q25. Addressing mode for arrays:

- a) Immediate                          b) Based/Indexed  
c) Register                              d) Relative

Answer: b

Q26. INT 21h is an example of:

- a) Hardware interrupt              b) Software interrupt  
c) Timer                                  d) Memory instruction

Answer: b

Q27. JMP LABEL uses:

- a) Immediate                          b) Direct/Relative  
c) Register                              d) Stack

Answer: b

Q28. ALU in 8086 performs:

- a) Logical & arithmetic operations
- b) Only logical operations
- c) Only arithmetic
- d) I/O operations

Answer: a

Q29. 8086 has how many general-purpose registers?

- a) 2
- b) 4
- c) 6
- d) 8

Answer: b

Q30. 8086 clock speed typically:

- a) 5 MHz – 10 MHz
- b) 1 GHz
- c) 100 MHz
- d) 16 MHz – 20 MHz

Answer: a

### Communication system:

#### 1. Basic Principles & Transmission (1-20)

1. Which of the following is **not** a fundamental element of a communication system?

- a) Transmitter
- b) Receiver
- c) Channel
- d) Regulator

✓ **Ans: d) Regulator**

2. The physical path between transmitter and receiver is called:

- a) Signal
- b) Channel
- c) Bandwidth
- d) Modulator

✓ **Ans: b) Channel**

3. The measure of information content of a message source is:

- a) Bandwidth
- b) Entropy
- c) Noise figure
- d) Gain

✓ **Ans: b) Entropy**

4. Bandwidth is expressed in:

- a) Seconds
- b) Hertz
- c) Bits
- d) Watts

✓ **Ans: b) Hertz**

5. A system's limitation due to noise is represented by:

- a) Modulation index
- b) SNR

- c) Attenuation
- d) Sampling rate

✓ **Ans: b) SNR**

6. The maximum data rate of a noiseless channel is given by:

- a) Nyquist theorem
- b) Shannon theorem
- c) Sampling theorem
- d) Carson's rule

✓ **Ans: a) Nyquist theorem**

7. The maximum data rate of a noisy channel is given by:

- a) Nyquist theorem
- b) Shannon capacity theorem
- c) Sampling theorem
- d) Hartley's law

✓ **Ans: b) Shannon capacity theorem**

8. The transmission medium with **highest bandwidth** is:

- a) Twisted pair
- b) Coaxial cable
- c) Optical fiber
- d) Radio waves

✓ **Ans: c) Optical fiber**

9. In a coaxial cable, signal attenuation mainly depends on:

- a) Frequency
- b) Noise

- c) Source power    d) Modulation type  
☒ **Ans: a) Frequency**
10. Which transmission medium uses total internal reflection?  
 a) Coaxial cable    b) Optical fiber  
 c) Microwave    d) Waveguide  
☒ **Ans: b) Optical fiber**
11. The source of information in communication is:  
 a) Transmitter    b) Channel  
 c) Message source    d) Receiver  
☒ **Ans: c) Message source**
12. Transmission capacity refers to:  
 a) Signal power  
 b) Noise figure  
 c) Maximum possible data rate  
 d) Antenna gain  
☒ **Ans: c) Maximum possible data rate**
13. Which modulation requires the least bandwidth?  
 a) AM    b) SSB  
 c) FM    d) PM  
☒ **Ans: b) SSB**
14. The measure of randomness of a source is called:  
 a) Gain    b) Entropy  
 c) Bandwidth    d) Fidelity  
☒ **Ans: b) Entropy**
15. Attenuation in fiber optic cable increases mainly due to:  
 a) Thermal noise  
 b) Absorption and scattering  
 c) Interference  
 d) Crosstalk  
☒ **Ans: b) Absorption and scattering**
16. Transmission media that is immune to EMI:

- a) Coaxial cable    b) Twisted pair  
 c) Optical fiber    d) Waveguide  
☒ **Ans: c) Optical fiber**
17. Which is **not** a guided medium?  
 a) Twisted pair    b) Optical fiber  
 c) Coaxial cable    d) Radio waves  
☒ **Ans: d) Radio waves**
18. Propagation delay is inversely proportional to:  
 a) Bandwidth    b) Transmission speed  
 c) Carrier frequency    d) Channel gain  
☒ **Ans: b) Transmission speed**
19. In analog systems, fidelity means:  
 a) Noise immunity  
 b) Faithful reproduction  
 c) Bandwidth efficiency  
 d) Power efficiency  
☒ **Ans: b) Faithful reproduction**
20. A repeater is used to:  
 a) Change frequency  
 b) Reduce noise  
 c) Extend transmission distance  
 d) Perform modulation  
☒ **Ans: c) Extend transmission distance**

## 2. Noise (21–35)

21. Noise generated by random thermal motion of electrons is called:  
 a) Shot noise  
 b) Thermal noise  
 c) Intermodulation noise  
 d) Transit-time noise  
☒ **Ans: b) Thermal noise**
22. Thermal noise power is proportional to:  
 a) Voltage    b) Frequency  
 c) Bandwidth    d) Wavelength  
☒ **Ans: c) Bandwidth**

23. Shot noise arises due to:  
a) Amplification  
b) Random emission of electrons  
c) Modulation  
d) Reflection  
**✓ Ans: b) Random emission of electrons**
24. Flicker noise is also called:  
a) White noise      b)  $1/f$  noise  
c) Gaussian noise      d) Impulse noise  
**✓ Ans: b)  $1/f$  noise**
25. Signal-to-noise ratio (SNR) is defined as:  
a) Input signal / input noise  
b) Output signal / input noise  
c) Signal power / Noise power  
d) Carrier power / Modulation index  
**✓ Ans: c) Signal power / Noise power**
26. If SNR = 20 dB, then signal power is:  
a) 10 times noise power  
b) 20 times noise power  
c) 100 times noise power  
d) 200 times noise power  
**✓ Ans: c) 100 times noise power**
27. Which noise is dominant at high frequencies?  
a) Thermal noise      b) Flicker noise  
c) Shot noise      d) Transit-time noise  
**✓ Ans: d) Transit-time noise**
28. Man-made noise in communication is strongest in:  
a) Microwave range      b) HF range  
c) Optical range      d) VHF range  
**✓ Ans: b) HF range**
29. Noise figure of an amplifier represents:  
a) Input power      b) Degradation in SNR  
c) Amplifier gain      d) Carrier-to-noise ratio  
**✓ Ans: b) Degradation in SNR**
30. Which of the following is a Gaussian noise?  
a) Impulse noise      b) White noise  
c) Flicker noise      d) Transit-time noise  
**✓ Ans: b) White noise**
31. Crosstalk is a form of:  
a) Impulse noise      b) Interference noise  
c) Thermal noise      d) Shot noise  
**✓ Ans: b) Interference noise**
32. In dB, SNR = 10 log:  
a)  $(S/N)$       b)  $(N/S)$   
c)  $(S \times N)$       d)  $(S+N)$   
**✓ Ans: a)  $(S/N)$**
33. Noise immunity is better in:  
a) Analog signals      b) Digital signals  
c) AM signals      d) SSB signals  
**✓ Ans: b) Digital signals**
34. In radio communication, atmospheric noise is also called:  
a) Impulse noise      b) Thermal noise  
c) Sky noise      d) Flicker noise  
**✓ Ans: c) Sky noise**
35. In communication, the ratio C/N is:  
a) Carrier to noise      b) Current to noise  
c) Channel to noise      d) Code to noise  
**✓ Ans: a) Carrier to noise**
- 
- 3. Analog Communication (36–55)**
36. In AM, the carrier contains:  
a) No information  
b) Half of the information  
c) All information  
d) Noise only  
**✓ Ans: a) No information**
37. Bandwidth required for AM with modulation frequency  $f_m$  is:  
a)  $f_m$       b)  $2f_m$

- c)  $f_c \pm f_m$       d)  $f_c + 2f_m$   
☒ **Ans: b)  $2f_m$**
38. Which sidebands are transmitted in DSB-SC?  
 a) Only upper sideband  
 b) Only lower sideband  
 c) Both sidebands without carrier  
 d) Both sidebands with carrier  
☒ **Ans: c) Both sidebands without carrier**
39. The advantage of SSB over DSB is:  
 a) Higher noise immunity  
 b) Reduced bandwidth and power  
 c) Higher carrier power  
 d) Easy demodulation  
☒ **Ans: b) Reduced bandwidth and power**
40. Vestigial sideband is commonly used in:  
 a) AM radio.      b) FM radio  
 c) TV transmission      d) Satellite links  
☒ **Ans: c) TV transmission**
41. Quadrature amplitude modulation (QAM) combines:  
 a) ASK and FSK      b) AM and PM  
 c) ASK and PSK      d) FM and PM  
☒ **Ans: c) ASK and PSK**
42. Envelope detector is used for:  
 a) FM      b) PM  
 c) AM      d) PCM  
☒ **Ans: c) AM**
43. In FM, the information is carried by:  
 a) Amplitude      b) Frequency deviation  
 c) Phase      d) Carrier power  
☒ **Ans: b) Frequency deviation**
44. Carson's rule gives bandwidth of:  
 a) AM      b) FM  
 c) PCM      d) ASK  
☒ **Ans: b) FM**
45. FM has better noise immunity than AM because:  
 a) Constant amplitude  
 b) Large bandwidth  
 c) Envelope detection  
 d) Low carrier power  
☒ **Ans: a) Constant amplitude**
46. PM can be converted into FM by:  
 a) Differentiator      b) Integrator  
 c) Rectifier      d) Mixer  
☒ **Ans: b) Integrator**
47. FM demodulation is done using:  
 a) Product detector  
 b) Foster-Seeley discriminator  
 c) Envelope detector  
 d) AM receiver  
☒ **Ans: b) Foster-Seeley discriminator**
48. AM transmitter efficiency improves by:  
 a) Increasing carrier power  
 b) Using SSB  
 c) Increasing bandwidth  
 d) Reducing modulation index  
☒ **Ans: b) Using SSB**
49. FM transmitter uses:  
 a) Direct or indirect method  
 b) Envelope detector  
 c) Coherent demodulation  
 d) Delta modulation  
☒ **Ans: a) Direct or indirect method**
50. AGC in receivers is used for:  
 a) Increasing gain  
 b) Reducing carrier  
 c) Maintaining constant output  
 d) Filtering noise  
☒ **Ans: c) Maintaining constant output**

51. Noise limiting circuits are used in:  
a) AM receivers    b) FM receivers  
c) PCM systems    d) Delta modulators

✓ **Ans: b) FM receivers**

52. In synchronous detection, a:  
a) Local carrier is used  
b) Filter is used  
c) Detector rectifies  
d) Signal is sampled

✓ **Ans: a) Local carrier is used**

53. In DSB-SC demodulation, synchronization is required between:  
a) Carrier and local oscillator  
b) Noise and signal  
c) Modulating and modulated signal  
d) Two sidebands

✓ **Ans: a) Carrier and local oscillator**

54. Instantaneous frequency is defined as:  
a) Derivative of phase  
b) Integral of amplitude  
c) Constant carrier  
d) RMS of signal

✓ **Ans: a) Derivative of phase**

55. Narrowband FM bandwidth is approximately:  
a)  $2f_m$                       b)  $2\Delta f$   
c)  $2(f_c + f_m)$             d)  $f_c \pm \Delta f$

✓ **Ans: a)  $2f_m$**

#### 4. Sampling & PCM (56–70)

56. Sampling theorem states that sampling rate must be at least:  
a)  $f_m$                       b)  $2f_m$   
c)  $f_c$                       d)  $f_m/2$

✓ **Ans: b)  $2f_m$**

57. Nyquist criterion is used for:  
a) Sampling              b) Zero ISI  
c) FM bandwidth        d) AM efficiency

✓ **Ans: b) Zero ISI**

58. Aliasing occurs when:  
a) Over-sampling  
b) Under-sampling  
c) Noise increases  
d) Bandwidth decreases

✓ **Ans: b) Under-sampling**

59. In natural sampling, pulses are:  
a) Flat topped    b) Proportional to signal  
c) Fixed height    d) Binary

✓ **Ans: b) Proportional to signal**

60. Flat-topped sampling introduces:  
a) Quantization error  
b) Aperture distortion  
c) Aliasing  
d) Phase error

✓ **Ans: b) Aperture distortion**

61. PAM requires bandwidth proportional to:  
a) Signal frequency  
b) Sampling frequency  
c) Carrier frequency  
d) Noise

✓ **Ans: b) Sampling frequency**

62. Quantization converts:  
a) Analog amplitude → digital levels  
b) Analog time → digital levels  
c) Bandwidth → time slots  
d) Phase → frequency

✓ **Ans: a) Analog amplitude → digital levels**

63. Quantization error is:  
a) Always zero    b) Signal-dependent  
c) Random              d) Deterministic

✓ **Ans: b) Signal-dependent**

64. Non-uniform quantization is used for:

- a) Speech signals    b) Random noise
- c) Video                d) Data signals

✓ **Ans: a) Speech signals**

65. SQNR increases with:

- a) Sampling rate    b) Quantization levels
- c) Bandwidth        d) Carrier power

✓ **Ans: b) Quantization levels**

66. Differential PCM reduces:

- a) Bandwidth        b) Quantization error
- c) Redundancy       d) Aliasing

✓ **Ans: c) Redundancy**

67. Delta modulation suffers from:

- a) Slope overload        b) Aliasing
- c) Aperture distortion    d) ISI

✓ **Ans: a) Slope overload**

68. Adaptive DM solves:

- a) Aliasing
- b) Aperture distortion
- c) Slope overload & granular noise
- d) ISI

✓ **Ans: c) Slope overload & granular noise**

69. Delta-sigma modulation is used for:

- a) Audio signals    b) High-resolution ADCs
- c) TV                d) FM

✓ **Ans: b) High-resolution ADCs**

70. Line coding converts:

- a) Bits → waveforms
- b) Analog → digital
- c) Frequency → phase
- d) Power → bandwidth

✓ **Ans: a) Bits → waveforms**

## 5. Digital Modulation (71–85)

71. ASK represents data by:

- a) Frequency variation

b) Phase variation

c) Amplitude variation

d) Time slots

✓ **Ans: c) Amplitude variation**

72. OOK is a form of:

- a) FSK                    b) PSK
- c) ASK                  d) PCM

✓ **Ans: c) ASK**

73. Bandwidth required for ASK equals:

- a) Bit rate                    b)  $2 \times \text{bit rate}$
- c) Half bit rate              d) Sampling rate

✓ **Ans: a) Bit rate**

74. In PSK, the data is carried in:

- a) Amplitude                b) Phase
- c) Frequency                d) Noise

✓ **Ans: b) Phase**

75. BPSK has:

- a) 1 bit per symbol    b) 2 bits per symbol
- c) 3 bits per symbol    d) 4 bits per symbol

✓ **Ans: a) 1 bit per symbol**

76. QPSK carries:

- a) 1 bit per symbol    b) 2 bits per symbol
- c) 3 bits per symbol    d) 4 bits per symbol

✓ **Ans: b) 2 bits per symbol**

77. Differential PSK avoids:

- a) Synchronization problem
- b) Bandwidth limitation
- c) Aliasing
- d) Noise

✓ **Ans: a) Synchronization problem**

78. In FSK, data is represented by:

- a) Frequency shifts
- b) Amplitude levels
- c) Phase states
- d) Noise

✓ **Ans: a) Frequency shifts**

79. MSK is a special form of:

- a) PSK                      b) FSK
- c) ASK                     d) PCM

✓ **Ans: b) FSK**

80. GMSK is used in:

- a) AM radio                      b) GSM cellular
- c) Satellite TV                      d) FM radio

✓ **Ans: b) GSM cellular**

81. M-ary modulation increases:

- a) Power efficiency
- b) Bandwidth efficiency
- c) Noise immunity
- d) Sampling rate

✓ **Ans: b) Bandwidth efficiency**

82. DSSS spreads signal by:

- a) Frequency hopping
- b) Pseudorandom code
- c) Time division
- d) Orthogonal carriers

✓ **Ans: b) Pseudorandom code**

83. FHSS spreads spectrum by:

- a) Rapidly changing frequency
- b) Increasing bandwidth
- c) Coding data
- d) Increasing SNR

✓ **Ans: a) Rapidly changing frequency**

84. Spread spectrum provides:

- a) Low noise
- b) High security & anti-jamming
- c) Reduced carrier power
- d) Narrow bandwidth

✓ **Ans: b) High security & anti-jamming**

85. QAM is mainly used in:

- a) Wireless LANs & TV    b) PCM systems
- c) Optical fiber only    d) Delta modulation

✓ **Ans: a) Wireless LANs & TV**

## 6. Multiplexing (86–100)

86. Multiplexing allows:

- a) Noise reduction
- b) Multiple signals over one channel
- c) Increased bandwidth
- d) Demodulation

✓ **Ans: b) Multiple signals over one channel**

87. TDM works by:

- a) Frequency slots.    b) Time slots
- c) Code division    d) Carrier shifting

✓ **Ans: b) Time slots**

88. In synchronous TDM, time slots are:

- a) Fixed                      b) Variable
- c) Random                      d) Skipped

✓ **Ans: a) Fixed**

89. Asynchronous TDM is also called:

- a) Statistical TDM                      b) FDM
- c) CDMA                                      d) TDMA

✓ **Ans: a) Statistical TDM**

90. Frame synchronization is required in:

- a) FDM                      b) TDM
- c) FM                      d) PCM

✓ **Ans: b) TDM**

91. TDM is used in:

- a) AM radio                      b) Telephone networks
- c) Satellite TV                      d) FM broadcast

✓ **Ans: b) Telephone networks**

92. FDM assigns:

- a) Frequency bands to each user
- b) Time slots
- c) Codes
- d) Spread spectrum

✓ **Ans: a) Frequency bands to each user**

## Logic Gates and Boolean Algebra

- The NOT gate has how many inputs?  
a) 0                      b) 1  
c) 2                      d) More than 2  
**✓ Ans: b) 1**
- The output of an AND gate is 1 when:  
a) Any input is 1    b) All inputs are 1  
c) All inputs are 0   d) Inputs are unequal  
**✓ Ans: b) All inputs are 1**
- Which gate is called a universal gate?  
a) AND                      b) OR  
c) NAND                      d) XOR  
**✓ Ans: c) NAND**
- Which of the following is NOT a logic gate?  
a) AND                      b) OR  
c) NOR                      d) EX-AND  
**✓ Ans: d) EX-AND**
- XOR gate output is high when:  
a) Inputs are same  
b) Inputs are different  
c) Both inputs are high  
d) Both inputs are low  
**✓ Ans: b) Inputs are different**
- A NOR gate is equivalent to:  
a) Inverted AND gate  
b) Inverted OR gate  
c) Inverted NAND gate  
d) Exclusive OR gate  
**✓ Ans: b) Inverted OR gate**
- Which law is used in Boolean algebra to simplify  $(A + A'B)$ ?  
a) Absorption Law    b) De Morgan's Law  
c) Distributive Law   d) Associative Law  
**✓ Ans: a) Absorption Law**
- De Morgan's Theorem states:  
a)  $(AB)' = A' + B'$                       b)  $(A + B)' = A'B'$   
c) Both (a) and (b)                      d) None  
**✓ Ans: c) Both (a) and (b)**
- The dual of AND operation is:  
a) NAND                      b) NOR  
c) OR                      d) XOR  
**✓ Ans: c) OR**
- The Boolean expression of a NAND gate with inputs A, B:  
a)  $A + B$                       b)  $AB$   
c)  $(AB)'$                       d)  $(A + B)'$   
**✓ Ans: c)  $(AB)'$**
- Simplify  $A + A'B = ?$   
a)  $A + B$                       b)  $B$   
c)  $A$                       d)  $AB$   
**✓ Ans: a)  $A + B$**   
$$A + A'B = (A + A')(A + B)$$
- In Boolean algebra,  $A + A = ?$   
a) 0                      b)  $A$   
c) 1                      d)  $A'$   
**✓ Ans: b)  $A$**
- $A + 1 = ?$   
a) 0                      b) 1  
c)  $A$                       d)  $A'$   
**✓ Ans: b) 1**
- $A \cdot 0 = ?$   
a) 0                      b)  $A$   
c) 1                      d)  $A'$   
**✓ Ans: a) 0**
- The simplified form of  $A + A'$  is:  
a) 0                      b) 1  
c)  $A$                       d)  $A'$   
**✓ Ans: b) 1**

16. Which gate can be used to build all other gates?

- a) XOR                      b) NAND  
c) AND                      d) OR

✓ **Ans: b) NAND**

17. The Karnaugh Map (K-map) is used for:

- a) Addition  
b) Multiplication  
c) Simplification of Boolean expressions  
d) Subtraction

✓ **Ans: c) Simplification of Boolean expressions**

18. Don't care conditions in K-map are used for:

- a) Increasing variables  
b) Minimization  
c) De Morgan's theorem  
d) Half Adder design

✓ **Ans: b) Minimization**

19. A function of 3 variables can be represented in K-map with how many cells?

- a) 4                      b) 6  
c) 8                      d) 16

✓ **Ans: c) 8**

#### Part B: Arithmetic Circuits (21–35)

21. A half adder is made of:

- a) XOR + AND              b) XOR + OR  
c) AND + NAND            d) OR + NOR

✓ **Ans: a) XOR + AND**

22. Half adder can add how many bits?

- a) 1-bit + 1-bit              b) 2-bit + 2-bit  
c) 4-bit + 4-bit              d) 8-bit + 8-bit

✓ **Ans: a) 1-bit + 1-bit**

23. Full adder adds:

- a) 2 bits              b) 3 bits

- c) 4 bits                      d) 8 bits

✓ **Ans: b) 3 bits (A, B, Cin)**

24. Which is used to overcome delay in ripple carry adder?

- a) Multiplexer                      b) Encoder  
c) Look-ahead carry adder      d) Decoder

✓ **Ans: c) Look-ahead carry adder**

25. In 2's complement subtraction, subtraction is performed by:

- a) Adding complement of subtrahend  
b) Using OR gates  
c) Using Decoder  
d) By shifting bits

✓ **Ans: a) Adding complement of subtrahend**

26. A full subtractor requires how many inputs?

- a) 2                      b) 3  
c) 4                      d) 1

✓ **Ans: b) 3**

27. The sum output of a half adder is:

- a)  $A + B$                       b)  $A \oplus B$   
c)  $A \text{ AND } B$                       d)  $A'B + AB'$

✓ **Ans: b)  $A \oplus B$**

28. Ripple carry adders are slow because:

- a) Large number of gates  
b) Propagation delay of carry  
c) They use XOR gates  
d) Require subtractors

✓ **Ans: b) Propagation delay of carry**

29. A BCD adder adds numbers in base:

- a) 2                      b) 8  
c) 10                      d) 16

✓ **Ans: c) 10**

30. To correct a sum greater than 9 in BCD adder, what is added?

- a) 1111 (15)                      b) 0110 (6)

c) 1001 (9)      d) 0001 (1)

✓ **Ans: b) 0110 (6)**

31. A half subtractor is made of:

- a) XOR + NAND      b) XOR + AND  
c) XOR + NOT      d) XOR + AND + NOT

✓ **Ans: d) XOR + AND + NOT**

32. Subtraction using 2's complement avoids:

- a) Carry      b) Overflow  
c) Borrow      d) Negative results

✓ **Ans: c) Borrow**

33. Which circuit performs both addition and subtraction?

- a) Half adder  
b) Full adder  
c) Arithmetic unit (Adder-Subtractor)  
d) Multiplexer

✓ **Ans: c) Arithmetic unit (Adder-Subtractor)**

34. A carry look-ahead adder is:

- a) Slower than ripple carry  
b) Faster than ripple carry  
c) Same as ripple carry  
d) Used only in subtraction

✓ **Ans: b) Faster than ripple carry**

35. A cascading BCD adder is used for:

- a) Single digit addition  
b) Multi-digit addition  
c) Subtraction only  
d) Multiplication

✓ **Ans: b) Multi-digit addition**

### Part C: Combinational Logic (36–50)

36. Decoder converts:

- a) Binary to decimal      b) Decimal to binary  
c) Binary to BCD      d) BCD to binary

✓ **Ans: a) Binary to decimal**

37. BCD to 7-segment decoder is used in:

- a) Memory      b) Display  
c) Registers      d) Counters

✓ **Ans: b) Display**

38. The output of a decoder is:

- a) Multiple      b) Single  
c) 2 only      d) Undefined

✓ **Ans: a) Multiple**

39. Encoder converts:

- a) Binary to decimal  
b) Decimal to binary  
c) Binary to octal  
d) Octal to binary

✓ **Ans: b) Decimal to binary**

40. A multiplexer is also called:

- a) Data selector      b) Data distributor  
c) Data encoder      d) Decoder

✓ **Ans: a) Data selector**

41. 8-to-1 multiplexer requires how many selection lines?

- a) 2      b) 3  
c) 4      d) 8

✓ **Ans: b) 3**

42. 16-to-1 MUX requires how many selection lines?

- a) 2      b) 3  
c) 4      d) 5

✓ **Ans: c) 4**

43. Which IC is Quad 2-input MUX?

- a) 74153      b) 7400  
c) 7486      d) 7432

✓ **Ans: a) 74153**

44. The reverse of multiplexer is:

- a) Encoder      b) Decoder  
c) Demultiplexer      d) Counter

✓ **Ans: c) Demultiplexer**

45. A 4-to-16 decoder requires:

- a) 2 inputs                      b) 4 inputs  
c) 16 inputs                    d) 8 inputs

✓ **Ans: b) 4 inputs**

46. A multiplexer with  $n$  selection lines can select how many inputs?

- a)  $2n$                               b)  $n^2$   
c)  $2n-1$                         d)  $n!$

✓ **Ans: a)  $2n$**

47. Decoder IC for BCD to decimal is:

- a) 7447                              b) 7442  
c) 74138                          d) 74153

✓ **Ans: b) 7442**

48. The IC 7447 is:

- a) BCD to decimal decoder  
b) BCD to 7-segment decoder  
c) Encoder  
d) Multiplexer

✓ **Ans: b) BCD to 7-segment decoder**

49. Multiplexers are used in:

- a) Data selection  
b) Switching  
c) Arithmetic operations  
d) All of the above

✓ **Ans: d) All of the above**

50. An encoder with 8 inputs will have:

- a) 2 outputs                      b) 3 outputs  
c) 4 outputs                      d) 8 outputs

✓ **Ans: c) 4 outputs**

#### Part D: Sequential Circuits & Flip-Flops (51-70)

51. A latch is:

- a) Level triggered  
b) Edge triggered  
c) Asynchronous device

d) Both (a) and (c)

✓ **Ans: d) Both (a) and (c)**

52. A flip-flop is:

- a) Level triggered  
b) Edge triggered  
c) Combinational circuit  
d) Decoder

✓ **Ans: b) Edge triggered**

53. The basic memory element in digital systems is:

- a) Encoder                              b) Flip-flop  
c) Counter                              d) Multiplexer

✓ **Ans: b) Flip-flop**

54. Which flip-flop suffers from race-around problem?

- a) SR                                      b) JK  
c) D                                        d) T

✓ **Ans: b) JK**

55. The Master-Slave JK flip-flop eliminates:

- a) Glitching  
b) Race-around condition  
c) Propagation delay  
d) Asynchronous input

✓ **Ans: b) Race-around condition**

56. The flip-flop used for switch debouncing is:

- a) SR                                      b) D  
c) JK                                        d) T

✓ **Ans: a) SR**

57. The D flip-flop is also known as:

- a) Toggle flip-flop  
b) Data/Delay flip-flop  
c) Race-around flip-flop  
d) Latch

✓ **Ans: b) Data/Delay flip-flop**

58. In a T flip-flop, when  $T = 1$ , the output will:

- a) Toggle                      b) Remain same
- c) Reset                        d) Set

✓ **Ans: a) Toggle**

59. Flip-flops can be used for:

- a) Data storage
- b) Frequency division
- c) Counters
- d) All of these

✓ **Ans: d) All of these**

60. The output of SR latch is invalid when:

- a)  $S = 0, R = 0$             b)  $S = 1, R = 0$
- c)  $S = 0, R = 1$             d)  $S = 1, R = 1$

✓ **Ans: d)  $S = 1, R = 1$**

61. Clocked flip-flops are used to:

- a) Avoid switch bouncing
- b) Synchronize inputs
- c) Avoid asynchronous operation
- d) All of the above

✓ **Ans: d) All of the above**

62. Edge detector circuits are used to:

- a) Detect level change
- b) Detect transition ( $0 \rightarrow 1$  or  $1 \rightarrow 0$ )
- c) Store data
- d) Divide frequency

✓ **Ans: b) Detect transition ( $0 \rightarrow 1$  or  $1 \rightarrow 0$ )**

63. Which flip-flop is best for shift registers?

- a) SR                              b) JK
- c) D                                d) T

✓ **Ans: c) D**

64. Setup and hold times are related to:

- a) Counters                      b) Decoders
- c) Flip-flops                      d) Multiplexers

✓ **Ans: c) Flip-flops**

65. The propagation delay in flip-flops affects:

- a) Switching speed              b) Memory
- c) Power consumption          d) None

✓ **Ans: a) Switching speed**

66. The asynchronous inputs in flip-flops are:

- a) Preset and Clear            b) Set and Reset
- c) Enable and Clock          d) Data and Toggle

✓ **Ans: a) Preset and Clear**

67. A JK flip-flop with  $J=K=1$  and clock applied will:

- a) Hold state                      b) Reset
- c) Set                                d) Toggle

✓ **Ans: d) Toggle**

68. Which flip-flop is simplest to implement?

- a) SR                                b) JK
- c) D                                 d) T

✓ **Ans: a) SR**

69. The minimum number of flip-flops required to store 1 byte is:

- a) 2                                  b) 4
- c) 8                                 d) 16

✓ **Ans: c) 8**

70. Parallel data transfer is achieved by:

- a) Multiplexers                  b) Shift registers
- c) Counters                      d) Buffers

✓ **Ans: b) Shift registers**

### Part E: Shift Registers & Counters (71–85)

71. A shift register transfers data:

- a) Only in parallel              b) Only in serial
- c) Serial and/or parallel       d) None

✓ **Ans: c) Serial and/or parallel**

72. A 4-bit ring counter has a modulus of:

- a) 2                                  b) 4
- c) 8                                 d) 16

✓ **Ans: b) 4**

73. A Johnson counter with 4 flip-flops has a modulus of:

- a) 4                      b) 6  
c) 8                      d) 10

✓ **Ans: b) 6**

74. An n-bit shift register can store:

- a) n bits                      b) 2n bits  
c)  $n^2$  bits                      d) Infinite bits

✓ **Ans: a) n bits**

75. In asynchronous counters, flip-flops are triggered by:

- a) Same clock  
b) Output of previous flip-flop  
c) Decoder  
d) Encoder

✓ **Ans: b) Output of previous flip-flop**

76. In synchronous counters, flip-flops are triggered by:

- a) Same clock                      b) Different clock  
c) Delayed clock                      d) Ripple signals

✓ **Ans: a) Same clock**

77. A 3-bit binary counter counts from:

- a) 0 to 3                      b) 0 to 7  
c) 0 to 15                      d) 0 to 8

✓ **Ans: b) 0 to 7**

78. Mod-10 counter is also called:

- a) Binary counter                      b) BCD counter  
c) Johnson counter                      d) Ring counter

✓ **Ans: b) BCD counter**

79. A mod-n counter has:

- a) n states                      b)  $n^2$  states  
c) 2n states                      d)  $\log_2 n$  states

✓ **Ans: a) n states**

80. A presettable counter allows:

- a) Automatic counting  
b) Preloading a value  
c) Counting only zero

d) Up counting only

✓ **Ans: b) Preloading a value**

81. A divide-by-N counter reduces frequency by:

- a) N times                      b)  $2N$  times  
c)  $N/2$  times                      d)  $\sqrt{N}$  times

✓ **Ans: a) N times**

82. Which counter is faster?

- a) Asynchronous  
b) Synchronous

✓ **Ans: b) Synchronous**

83. A 4-bit synchronous counter has how many states?

- a) 2                      b) 8  
c) 16                      d) 32

✓ **Ans: c) 16**

84. Ring counters are used in:

- a) Timing circuits  
b) Frequency dividers  
c) Control sequences  
d) All of these

✓ **Ans: d) All of these**

85. A Johnson counter has how many states with 5 flip-flops?

- a) 5                      b) 8  
c) 10                      d) 16

✓ **Ans: c) 10**

#### Part F: ADC & DAC (86–92)

86. Which ADC is fastest?

- a) Ramp  
b) Flash  
c) Successive Approximation  
d) Dual slope

✓ **Ans: b) Flash**

87. The most common DAC circuit is:

- a) R-2R ladder  
b) Binary-weighted resistor  
c) Successive approximation  
d) Flash

✓ **Ans: a) R-2R ladder**

88. In DAC, resolution depends on:

- a) Clock speed
- b) Number of bits
- c) Voltage reference
- d) All of these

✓ **Ans: b) Number of bits**

89. Successive approximation ADC is:

- a) Slowest
- b) Fastest
- c) Moderate speed
- d) Not used

✓ **Ans: c) Moderate speed**

90. Dual slope ADC is best suited for:

- a) High speed
- b) Low cost
- c) High accuracy
- d) None

✓ **Ans: c) High accuracy**

91. DAC converts:

- a) Analog to digital
- b) Digital to analog
- c) Frequency to digital
- d) Analog to binary only

✓ **Ans: b) Digital to analog**

92. ADC converts:

- a) Analog to digital
- b) Digital to analog
- c) Digital to frequency
- d) Analog to binary only

✓ **Ans: a) Analog to digital**

#### Part G: MOSFET Logic & PLDs (93–100)

93. CMOS consists of:

- a) NMOS only
- b) PMOS only
- c) Both NMOS and PMOS
- d) Bipolar transistors

✓ **Ans: c) Both NMOS and PMOS**

94. CMOS circuits consume less power because:

- a) Both transistors ON
- b) Only one transistor conducts at a time
- c) High current flow
- d) Bipolar design

✓ **Ans: b) Only one transistor conducts at a time**

95. The main advantage of CMOS over TTL is:

- a) Speed
- b) Noise immunity and low power
- c) Complexity
- d) Cost

✓ **Ans: b) Noise immunity and low power**

96. A programmable logic device (PLD) is:

- a) Fixed logic device
- b) User programmable
- c) Memory only
- d) Decoder only

✓ **Ans: b) User programmable**

97. PLA stands for:

- a) Programmable Logic Array
- b) Programmed Logic Application
- c) Parallel Logic Array
- d) Programmable Linear Array

✓ **Ans: a) Programmable Logic Array**

98. FPGA stands for:

- a) Fast Programmable Gate Array
- b) Field Programmable Gate Array
- c) Functional Programmable Gate Array
- d) Field Programmed Gate Access

✓ **Ans: b) Field Programmable Gate Array**

99. The advantage of FPGA over PLA is:

- a) Limited programmability
- b) Reconfigurability and complexity handling
- c) Low speed
- d) High power

✓ **Ans: b) Reconfigurability and complexity handling**

100. Which is NOT a programmable logic device?

- a) PLA
- b) FPGA
- c) Decoder
- d) CPLD

✓ **Ans: c) Decoder**