UPPSC-AE

UTTAR PRADESH PUBLIC SERVICE COMMISSION

Combined State Engineering
Services Examination

Assistant Engineer

Electrical Engineering

Previous Years Solved Papers

Objective Papers

General Hindi

General Studies

Practice Questions

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UPPSC-AE : Electrical Engineering Previous Solved Papers

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Preface

B. Singh (Ex. IES)

UPPSC Assistant Engineer Examination has been always preferred by Engineers due to job stability and opportunity to work in home sate. UPPSC Combined State Engineering Services examination is conducted time to time but not every year. MADE EASY team has made deep study of previous exam papers and observed that a good percentage of questions are of repetitive in nature, therefore previous year's papers are advisable to solve before a candidate takes the exam. This book is also useful for MP State Engineering Services, UPSC Engineering Services and other Competitive exams for Engineering graduates.

The current edition of this book contains complete solutions to all questions with accuracy. I have true desire to serve student community by providing good source of study and quality guidance. I hope this book will be proved an important tool to succeed in UPPSC and other competitive exams. Any suggestions from the readers for improvement of this book are most welcome.

With Best Wishes

B. Singh

CMD, MADE EASY

UPPSC : Exam Pattern

Combined State Engineering Services Examination
Assistant Engineer examination

Paper I : Objective **Maximum Time : 2½ Hours • Maximum Marks : 375** Each question carries 3 marks. There is a penalty of –1 mark for every wrong attempted answer	
General Hindi	25 Questions
Technical Paper I	100 Questions
Total	**125 Questions** (375 Marks)

Paper II : Objective **Maximum Time : 2½ Hours • Maximum Marks : 375** Each question carries 3 marks. There is a penalty of –1 mark for every wrong attempted answer	
General Studies	25 Questions
Technical Paper II	100 Questions
Total	**125 Questions** (375 Marks)

Uttar Pradesh Public Service Commission
Combined State Engineering Services Examination
Assistant Engineer
Electrical Engineering

Paper-I

Networks and Systems :
Steady-state and Transient-state Analysis of systems, Thevenin's- Norton's-, Superposition- and Maximum Power Transfer theorems, Driving point transfer functions, Two-port networks, Laplace and Fourier transforms and their applications in network analysis, Z-transforms for discrete systems, R-L, R-C & L-C network synthesis.

E.M. Theory :
Analysis of electrostatic and magnetostatic fields, Laplace, Poission and Maxwell equations, Solution of boundary value problems, electromagnetic wave propagation, Ground and space waves, Propagation between Earth Station and Satellites.

Control Systems :
Mathematical modelling of dynamic linear continuous systems, Block diagrams and signal flow graphs, time-response specifications, steady-state error, Routh-Hurwitz criterion, Nyquist techniques, Root Loci, Bode Plots, Polar Plot and stability analysis, Lag-, Lead-, Lag-Lead compensation, state-space modelling, state transition matrix, controllability and observability.

Elements of Electronics :
Basics of semiconductor diodes, BJT, FET and their characteristics, different types of transistors and FET amplifiers equivalent circuits and frequency response, feedback oscillators, colpitts oscillator and Hartley Oscillator, Operational amplifiers-characteistic and applications.

Power System Analysis and Design :
Line parameters and calculations, Performance of transmission lines, Mechanical design of overhead lines and insulators, Corona radio interference parameters of single- and three-core cables, Bus admittance matrix, Load flow equations and methods of solutions, Fast-decoupled load flow, Balance- and unbalanced-faults analysis, Power system stability, Power system transients and travailing waves, EHV transmission, HVDC transmission, Concepts of FACTS, Voltage control and economic operation, Concepts of distributed generation, solar and wind power, smart grid conclepts.

Elements of Electrical Machines :
General concepts of e.m.f., m.m.f. and torque in rotating machines, DC machines: motor and generator characteristics, equivalent circuits, commutation and amature reaction, starting and speed controls of motors; Synchronous machines: performance, regulation, parallel operation of generators, motor starting, characteristics and applications, Transformers: phasor-diagram and equivalent circuit, efficiency and voltage regulation, auto-transformers, 3-phase transformers.

Measurement :
Basic methods of measurement, Precision and standards, error analysis, Bridges and Poteniometers; moving coil, moving iron, dynamometer and induction type instruments, measurement of voltage, current, power, energy, and power factor, instrument transformers, digital voltmeters and multimeters, phase-, time- and frequency-measurement, Q-meters oscilloscopes, Basics of sensors and data acquisition system, instrumentation systems for pressure and temperature measurements.

Paper-II

Power Electronics and Drives :

Semiconductor, power, diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs static characteristics and principles of operation, triggering circuits single phase and three-phase controlled rectifiers-fully controlled and half controlled, smoothing and filters regulated power supplies, DC-DC choppers and inverters, speed control circuits for DC and AC drives, Basics of electric drives: types, quadrant operation, revesing and braking of electric motors, estimation of power ratings, traction motors.

Digital Electronics :
Boolean algebra, logic gates, combinational and sequential logic circuits, multiplexers, multivibrators, sample and hold circuits, A/D and D/A converters, basics of filter circuits and applications, active filters, semiconductor memories.

Microwaves and Communication Systems : Electromagnetic wave in guided media, wave guide components, resonators, microwave tubes, microwave generators and amplifiers.

Analog Communication Basic :

Modulation and demodulation, noise and bandwidth, transmitters and receivers, signal to noise ratio, digital communication basics, sampling, quantizing, coding frequency- and time-domain multiplexing, sound and vision broadcast, antennas, transmission lines at audio and ultra-high frequencies.

Induction and special Machines :

Three-phase induction motors rotating magnetic field, torque-slip characteristics, Equivalent circuit and determination of its parameters, starters, speed control, Induction generators, Single phase induction motors; theory and phasor diagrams, characteristics, starting and applications, repulsion motor, series motor: e.m.f. equation and phasor diagram and performance, servomotors, stepper motors, reluctance motors, brushless DC motors (BLDC).

Power System Protection and Switch Gear :

Methods of Arc Extinction, Restriking voltages and recovery voltage, testing of circuit breakers, Protective relays, protective schemes for power system equipment, surges in transmission lines and protection.

Numerical Methods :

Solution of non-linear algebraic equations, single and multisteps methods for solution of differential equations.

Electrical Engineering Materials :

Crystal structure and defects, conducting, insulating and magneting materials, super-conductors.

Elements of Microprocessors :

Data representation and representation of integer and floating point-numbers. Organization and programming of a microprocessor, ROM and RAM memories CPU of a microcomputer, interfacing memory and I/O devices, Programmable peripheral and communication interface. Application of microprocessors.

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UPPSC-AE

Combined State Engineering
Services Examination

Section-A

Electrical Engineering

Objective Previous Years Questions

UPPSC-AE 2013

Electrical Engineering : Paper-I

(Memory Based)

Q.1 A control system is defined by

$$\frac{d^2x}{dt^2} + \frac{6dx}{dt} + 5x = 12(1 - e^{-2t})$$

The response of system at t $\to \infty$ is

(a) $x = 6$ (b) $x = 2$

(c) $x = 2.4$ (d) $x = -2$

Q.2 The closed loop transfer function of a control system is given by $\frac{C(s)}{R(s)} = \frac{1}{1+s}$. For input $r(t) = \sin t$, the steady value of $C(t)$ is equal to

(a) $\frac{1}{\sqrt{2}}\cos t$ (b) 1

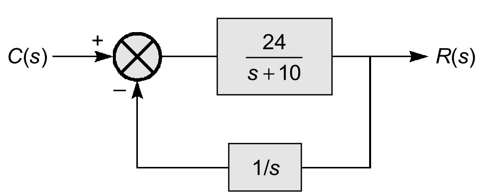
(c) $\frac{1}{\sqrt{2}}\sin t$ (d) $\frac{1}{\sqrt{2}}\sin\left(t - \frac{\pi}{4}\right)$

Q.3 The steady state error due to a step input for type 1 system is

(a) Infinite (b) Negative

(c) Negligible (d) Zero

Q.4 The roots of a closed-loop characteristic equation for the system shown are:



(a) –4, –10 (b) –4, –6

(c) –4, +6 (d) –4, +10

Q.5 The type of the system having transform function $G(s)H(s) = \frac{K}{s^3 + 2s^2 + 3s}$ is

(a) 1 (b) 2

(c) 3 (d) 4

Q.6 The impulse response of the system

$$\frac{C(s)}{R(s)} = \frac{8}{s(s+2)(s+4)}$$

is

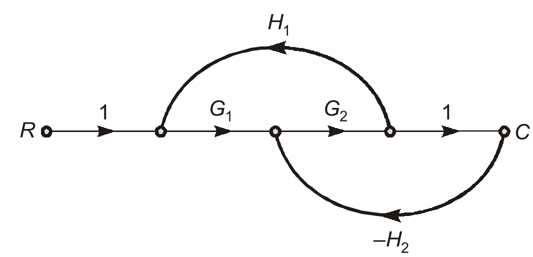
(a) $C(t) = 2 - e^{-2t} + e^{-4t}$

(b) $C(t) = 1 + 2e^{-2t} - 4e^{-4t}$

(c) $C(t) = 1 - 2e^{-2t} + e^{-4t}$

(d) $C(t) = 2 + e^{-2t} - 4e^{-4t}$

Q.7 The overall transfer function for the signal flow graph shown is



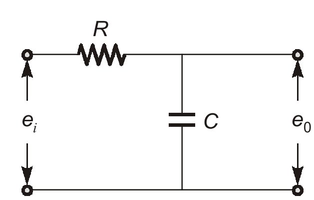
(a) $\frac{G_1G_2}{(1 - G_1G_2H_1 + G_2H_2)}$

(b) $\frac{G_1G_2}{(1 + G_1G_2H_1 + G_2H_2)}$

(c) $\frac{G_1G_2}{(1 - G_1G_2H_1 - G_2H_2)}$

(d) $\frac{G_1G_2}{(1 + G_1G_2H_2 + G_2H_1)}$

Q.8 The transfer function for the network shown is



(a) $\frac{1}{(RCs + 1)}$ (b) $(RCs + 1)$

(c) $\frac{1}{\left(\frac{R}{C}s + 1\right)}$ (d) $\left(\frac{R}{C}s + 1\right)$

Q.9 The value of function $f(s) = \frac{2}{s^2 + 3}$ at $t = 0$ is

(a) 3 (b) 2

(c) $\frac{3}{2}$ (d) zero

Q.10 The initial slope of the Bode plot gives an indication of
(a) Nature of the system time response
(b) System stability
(c) Marginally stable
(d) Unstable

Q.11 The value of 'k' at which the root locus crosses the imaginary axis, makes the system
(a) Stable (b) Underdamped
(c) Marginally stable (d) Unstable

Q.12 For the following characteristic equation, the centroid of the root locus plot is $s^3 + 2s + ks + k = 0$
(a) 0.5 (b) –0.5
(c) –1 (d) 1

Q.13 The transfer function of a system is $G(s) = \frac{s+6}{ks^2+s+6}$. If the damping ratio is unity, the value of k is
(a) $\frac{1}{6}$ (b) $\frac{1}{12}$
(c) $\frac{1}{24}$ (d) $\frac{1}{36}$

Q.14 The state transition matrix e^{AT} for a given matrix

$$A = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \text{ is}$$

(a) $\begin{bmatrix} 0 & e^{-t} \\ e^{-t} & 0 \end{bmatrix}$ (b) $\begin{bmatrix} e^{t} & 0 \\ 0 & e^{t} \end{bmatrix}$
(c) $\begin{bmatrix} e^{-t} & 0 \\ 0 & e^{-t} \end{bmatrix}$ (d) $\begin{bmatrix} 0 & e^{t} \\ e^{t} & 0 \end{bmatrix}$

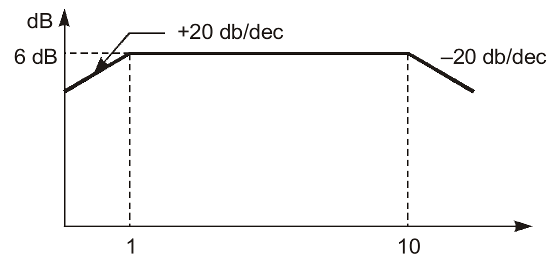
Q.15 Transfer function of a control system is

$$\frac{Y(s)}{U(s)} = \frac{2}{s^3+6s^2+11s+6}$$

the system is,
(a) controllable and observable
(b) controllable but not observable
(c) observable but not controllable
(d) neither controllable nor observable

Q.16 The output of a linear system for a unit step input is given by $t^2 \cdot e^{-t}$. The transfer function of the system will be
(a) $\frac{s}{s(s+1)^3}$ (b) $\frac{2}{s(s+1)^2}$
(c) $\frac{1}{s^2(s+1)}$ (d) $\frac{2s}{s(s+1)^2}$

Q.17 The transfer function of the system whose Bode plot is shown, will be



(a) $\frac{10s}{(s+1)(s+10)}$ (b) $\frac{20s}{(s+1)(s+10)}$
(c) $\frac{10}{(s+1)^2(s+10)}$ (d) $\frac{20}{(s+1)(s+10)^2}$

Q.18 The transfer function has its zero in the right half of the s-plane. The function
(a) Is positive real
(b) Will give stable impulse response
(c) Is in minimum phase
(d) Is in non-minimum phase

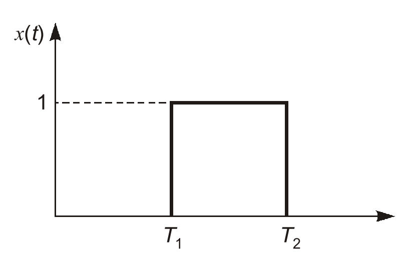
Q.19 The maximum phase shift that can be provided by a lead compensator with transfer function

$$G(s) = \frac{1+6s}{1+2s}$$

(a) 15° (b) 45°
(c) 30° (d) 60°

Q.20 State space analysis is applicable even if the initial conditions are
(a) zero (b) non zero
(c) equal (d) not equal

Q.21 The Laplace transform of the figure shown, is



(a) $\frac{e^{-ST_1}}{S} - \frac{e^{-ST_2}}{S}$ (b) $\frac{e^{-ST_1}}{S} + \frac{e^{-ST_2}}{S}$

(c) $\frac{e^{-ST_1}}{S^2} - \frac{e^{-ST_2}}{S^2}$ (d) $\frac{e^{-ST_1}}{S^2} + \frac{e^{-ST_2}}{S^2}$

Q.22 In a bode magnitude plot, which one of the following slopes would be exhibited at high frequency by a 4th order all pole system?
(a) –80 db/decade (b) –40 db/decade
(c) –20 db/decade (d) 20 db/decade

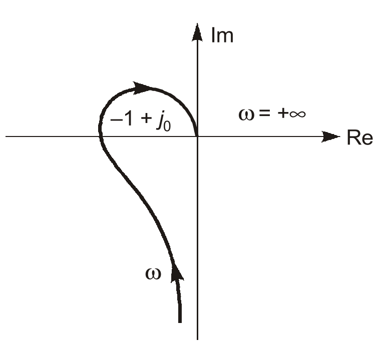
Q.23 If open loop transfer function contains one zero in right half of s-place, then
(a) close loop system is unstable
(b) open loop system is unstable
(c) close loop system is unstable for higher gain
(d) close loop system is stable

Q.24 The acceptable band of the settling time 't_s' is
(a) ±20%
(b) 10%
(c) 5%
(d) Both (a) and (c) depending on applications

Q.25 A unity feedback system has transfer function $G(s) = \frac{3}{s^2 + 4s + 9}$, its natural frequency will be
(a) 1 (b) 3
(c) 6 (d) 9

Q.26 The frequency at which the magnitude plot in a Bode plot crosses zero the db line, line is termed as
(a) Natural frequency
(b) Corner frequency
(c) Phase crossover frequency
(d) Gain crossover frequency

Q.27 As observed from the polar plot shown



(a) GM is (+)ve, PM is (+)ve
(b) GM is (–)ve, PM is (–)ve
(c) GM is (–)ve, PM is (+)ve
(d) GM is (+)ve, PM is (–)ve

Q.28 The standard test signal in control system is/are
(a) Impulse signal (b) Ramp signal
(c) Unit step signal (d) All of the above

Q.29 For a second order control system has a transfer function $\frac{16}{s^2 + 4s + 16}$. Find the setting time for 2% tolerance?
(a) 10 sec (b) 5 sec
(c) 4 sec (d) 2 sec

Q.30 The minimum number of states required to describe the two degree differential equation is
(a) 1 (b) 3
(c) 2 (d) 4

Q.31 An unloaded generator with a pre-fault voltage 1 pu has the following sequence impedances: $Z_0 = j0.15$ pu, $Z_1 = Z_2 = j0.25$ pu. The neutral is grounded with a reactance of 0.05 pu. The fault current in pu for a single line to ground fault is
(a) 3.75 pu (b) 4.28 pu
(c) 6.0 pu (d) 7.2 pu

Q.32 If a voltage controller bus is treated as load bus, then which one of the following limits would be violated?
(a) Voltage (b) Active power
(c) Reactive power (d) Phase angle

Q.33 In a short transmission line, resistance and inductance are found to be equal and regulation appears to be zero, then the load will be
(a) unity power factor
(b) zero power factor
(c) 0.707 lagging
(d) 0.707 leading

Q.34 Magnetic field intensity (H) of a long conductor carrying current 'I' at a distance 'r' is
(a) $\frac{I}{4\pi r}$ (b) $\frac{1}{2r}$
(c) $\frac{I}{4r}$ (d) $\frac{I}{2r}$

Q.35 If the positive, negative and zero sequence reactances of an element of a power system are
(a) synchronous generator
(b) synchronous motor
(c) static load
(d) transmission line

Q.36 Corona loss is less when shape of the conductor is
(a) Circular
(b) Flat
(c) Oval
(d) Independent of shape

Q.37 Overhead lines generally use
(a) Copper conductors
(b) All aluminium conductors
(c) ACSR conductors
(d) Insulated conductors

Q.38 The economic size of conductor is determined by
(a) Kirchhoff's law (b) Ohm's law
(c) Kelvin's law (d) Faraday's law

Q.39 If '*r*' is the radius of the conductor and '*R*' the radius of the sheath of the cable. The cable operates stably from the view point of dielectric strengths if
(a) $\frac{r}{R} > 1.0$ (b) $\frac{r}{R} < 1.0$
(c) $\frac{r}{R} < 0.632$ (d) $\frac{r}{R} < 0.368$

Q.40 Which of the following is not a type of insulator used in overhead transmission line?
(a) Rivet type (b) Pin type
(c) Suspension type (d) Strain type

Q.41 A bipolar HUDC transmission line has two poles
(a) one positive and other negative
(b) both positive
(c) both negative
(d) none of the above alternatives

Q.42 While building BUS ($m \times m$), if the added element is a branch, then the new bus impedance matrix will be of dimension
(a) $m \times m$
(b) $(m + 1) \times (m + 1)$
(c) $(m - 1) \times (m - 1)$
(d) $\frac{m(m+1)}{2}$

Q.43 The main criterion for the design of a distributor is
(a) Voltage drop (b) Corona loss
(c) Temperature rise (d) Radio interference

Q.44 Which of the following effect represents increase in resistance due to non-uniform distribution of current i a conduction?
(a) Proximity (b) Skin
(c) Corona (d) None of these

Q.45 If the inductance of a line increases, transmission capacity will
(a) Increase
(b) Decrease
(c) Remain same
(d) Independent of inductance

Q.46 Three equal impedance ($R + jX$) connected in delta carry a balanced line current of I_L. The total active and reactive power drawn by these are:
(a) I_L^2R and I_L^2X respectively
(b) $3I_L^2R$ and $3I_L^2X$ respectively
(c) $I_L^2\frac{R}{3}$ and $I_L^2\frac{X}{3}$ respectively
(d) I_L^2X and I_L^2R respectively

Q.47 If the fault current is 2000 A, the relay setting is 50% and CT ratio is 400 : 5, then plug setting multiplier will be
(a) 25 A (b) 15 A
(c) 50 A (d) 10 A

Q.48 A conductor is composed of seven identical copper strands of radius '*r*' each. What is the self GMD (Geometric Mean Distance) of the conductor?
(a) 2.771 *r* (b) 2.177 *r*
(c) 7.122 *r* (d) 7.777 *r*

Q.49 The velocity of a travelling wave through a cable of relative permittivity of 9 is
(a) 9×10^8 m/sec (b) 3×10^8 m/sec
(c) 10^8 m/sec (d) 2×10^8 m/sec

Q.50 The per unit impedance of a synchronous machine is 0.242. If the base voltage is increased by 1.1 times, the per unit value will be
(a) 0.200 (b) 0.266
(c) 0.242 (d) 0.220

Q.51 The critical clearing time of a fault in power systems is related to
(a) Reactive power limit
(b) Transient stability limit
(c) Steady state stability limit
(d) Short-circuit current limit

Q.52 The leakage resistance of a 50 km long cable is 1 M. For a 100 km long cable it will be
(a) 1 M (b) 2 M
(c) 0.66 M (d) 0.5 M

Q.53 A single-phase load of 100 kVA is delivered at 2000 V over a transmission line having R = 1.4 and X = 0.8. The voltage at the sending end, when the power factor of the load is unity, will be
(a) 1.68 kV (b) 2.98 kV
(c) 2.70 kV (d) 2.84 kV

Q.54 The breakdown strength at STP is 21 kV/cm. It's breakdown strength at 30°C and 72 cm of Hg. will be
(a) 21.25 kV/cm (b) 20.2 kV/cm
(c) 23 kV/cm (d) 19.5 kV/cm

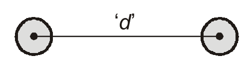
Q.55 The coefficient of reflection of voltage for a short circuited line is
(a) 1.0 (b) –1.0
(c) 0 (d) 2.0

Q.56 String efficiency of a suspension insulator string is improved by
(a) longer cross arm
(b) using discs of different sizes
(c) using guard ring
(d) capacitive grading

Q.57 In a n-phase one way converter, the d.c. output voltage is,
(a) $\dfrac{E_m \cos(\pi/n)}{(\pi/n)}$ (b) $\dfrac{E_m \sin(\pi/n)}{(\pi/n)}$
(c) $E_m/\sqrt{2}$ (d) None of these

Q.58 A power station consists of two synchronous generators A and B ratings 250 MVA and 500 MVA with inertia 1.6 p.u. and 1.0 p.u. respectively on their own base MVA ratings. The equivalent p.u. inertia constant for the system on 100 MVA common base is
(a) 2.6 (b) 1.625
(c) 0.615 (d) 2.0

Q.59 In a bundle conductors, if 'D_s' is the Geometric Mean Radius (GMR) of each subconductor and 'd' is the bundle spacing as shown in figure then for the two subconductor bundle



(a) $D_S^b = \sqrt{(D_S \times d)}$ (b) $D_S^b = \sqrt{(D_S \times d)^{1/2}}$
(c) $D_S^b = \sqrt{(D_S \times d)^2}$ (d) $D_S^b = 3\sqrt{(D_S \times d)}$

Q.60 In a power system, the maximum number of buses are:
(a) PV buses (b) Slack buses
(c) PQ buses (d) Any of the above

Q.61 In case of dc series motor, it is possible to have finite no-load speed if a resistance is connected across its
(a) Field terminals
(b) Armature terminals
(c) Field and armature together
(d) It is not possible

Q.62 A single-phase full bridge diode rectifier delivers a constant load current of 10 A. Average and rms value of source current are respectively
(a) 5 A, 10 A (b) 10 A, 10 A
(c) 5 A, 5 A (d) 0 A, 10 A

Q.63 A power semiconductor may undergo damage due to
(a) High di/dt (b) Low di/dt
(c) High dv/dt (d) Low dv/dt

Q.64 A pulse transformer is used in a driver circuit
(a) to prevent dc triggering
(b) to shape the trigger signal
(c) to generate high frequency pulses
(d) to provide isolation

Answers **UPPSC-AE Paper-I : 2013**

1.	(c)	2.	(d)	3.	(d)	4.	(b)	5.	(a)	6.	(c)	7.	(d)	8.	(a)
9.	(d)	10.	(d)	11.	(c)	12.	(b)	13.	(b)	14.	(b)	15.	(a)	16.	(d)
17.	(b)	18.	(d)	19.	(c)	20.	(b)	21.	(d)	22.	(a)	23.	(c)	24.	(d)
25.	(b)	26.	(d)	27.	(b)	28.	(d)	29.	(b)	30.	(c)	31.	(a)	32.	(c)
33.	(d)	34.	(d)	35.	(d)	36.	(a)	37.	(c)	38.	(c)	39.	(d)	40.	(a)
41.	(a)	42.	(b)	43.	(a)	44.	(b)	45.	(b)	46.	(b)	47.	(d)	48.	(b)
49.	(c)	50.	(a)	51.	(b)	52.	(d)	53.	(c)	54.	(a)	55.	(b)	56.	(a)
57.	(b)	58.	(*)	59.	(a)	60.	(c)	61.	(d)	62.	(d)	63.	(a)	64.	(d)
65.	(b)	66.	(d)	67.	(b)	68.	(b)	69.	(b)	70.	(a)	71.	(b)	72.	(a)
73.	(b)	74.	(c)	75.	(d)	76.	(d)	77.	(b)	78.	(c)	79.	(a)	80.	(b)
81.	(b)	82.	(c)	83.	(b)	84.	(b)	85.	(c)	86.	(d)	87.	(a)	88.	(d)
89.	(a)	90.	(b)	91.	(d)	92.	(c)	93.	(c)	94.	(a)	95.	(b)	96.	(*)
97.	(b)	98.	(a)	99.	(b)	100.	(d)	101.	(c)	102.	(d)	103.	(a)	104.	(d)
105.	(c)	106.	(a)	107.	(b)	108.	(c)	109.	(a)	110.	(d)	111.	(a)	112.	(d)
113.	(c)	114.	(d)	115.	(b)	116.	(b)	117.	(c)	118.	(a)	119.	(a)	120.	(c)
121.	(b)	122.	(c)	123.	(d)	124.	(d)	125.	(a)	126.	(a)	127.	(b)	128.	(c)
129.	(b)	130.	(d)	131.	(c)	132.	(b)	133.	(d)	134.	(c)	135.	(a)	136.	(d)
137.	(d)	138.	(d)	139.	(a)	140.	(c)	141.	(d)	142.	(d)	143.	(b)	144.	(a)
145.	(a)	146.	(a)	147.	(c)	148.	(a)	149.	(d)	150.	(d)	151.	(c)	152.	(d)
153.	(b)	154.	(a)	155.	(d)	156.	(c)	157.	(b)	158.	(a)	159.	(c)	160.	(a)
161.	(b)	162.	(a)	163.	(b)	164.	(b)	165.	(b)	166.	(d)	167.	(c)	168.	(d)
169.	(c)	170.	(b)	171.	(a)	172.	(c)	173.	(a)	174.	(c)	175.	(b)	176.	(c)
177.	(c)	178.	(a)	179.	(d)	180.	(b)								

■■■■

Explanations

1. (c)

Given system

$$\frac{d^2x}{dt^2}+\frac{6dx}{dt}+5x = 12(1-e^{-2t})$$

$$s^2x(s) + 6sx(s) + 5x(s) = 12\left(\frac{1}{s}-\frac{1}{s+2}\right)$$

$$x(s)\,(s^2 + 6s + 5) = 12\left(\frac{s+2-s}{s(s+2)}\right)$$

$$x(s) = \frac{24}{s(s+2)(s^2+6s+5)}$$

The response of the system at $t \to \infty$ is

$$\lim_{s\to 0} sx(s) = \lim_{s\to 0} s\times\frac{24}{s(s+2)(s^2+6s+5)}$$

$$= 2.4$$

2. (d)

$$F(s) = \frac{C(s)}{R(s)} = \frac{1}{1+s} = \frac{1}{1+j\omega}$$

$$|F(j\omega)| = \frac{1}{\sqrt{1+\omega^2}}$$

$$\angle(F(j\omega)) = -\tan^{-1}\omega$$

Given, [sin t] = input, $\therefore$ $\omega = 1$

$$|F(j\omega)| = \frac{1}{\sqrt{2}}$$

$$\angle F(j\omega) = -45°$$

Output is therefore $\frac{1}{\sqrt{2}}\sin(t-45°)$

3. (d)

There will be no steady-state error of step input.

4. (b)

$$\frac{C(s)}{R(s)} = \frac{\frac{24}{s+10}}{1+\frac{24}{s(s+10)}}$$

$$\frac{C(s)}{R(s)} = \frac{24s}{s^2+10s+24}$$

Characteristics equation $s^2 + 10s + 24 = 0$

$s^2 + 4s + 6s + 24 = 0$

$$s = -4, -6$$

5. (a)

Given,

$$G(s)H(s) = \frac{K}{s^3+2s^2+3s}$$

$$= \frac{K}{s(s^3+2s+3)}$$

Hence type of the system is 1.

6. (c)

Given impulse response of the system

$$\frac{C(s)}{R(s)} = \frac{8}{s(s+2)(s+4)}$$

$$= \frac{A}{s}+\frac{B}{(s+2)}+\frac{C}{(s+4)}$$

$$= \frac{A(s+2)(s+4)+Bs(s+4)+Cs(s+2)}{s(s+2)(s+4)}$$

$$= \frac{A(s^2+4s+2s+8)+B(s^2+4s)+C(s^2+2s)}{s(s+2)(s+4)}$$

$$A + B + C = 0$$
$$6A + 4B + 2C = 0$$
$$8A = 8$$
$$A = 1$$
$$B + C = -1$$
$$4B + 2C = -6$$
$$2B + 2C = -2$$
$$- \quad - \quad +$$

$$2B = -4$$
$$B = -2$$
$$A + B + C = 0$$
$$1 - 2 + C = 0$$
$$C = 1$$

$$= \frac{1}{s}-\frac{1}{(s+2)}+\frac{1}{(s+4)}$$

$$= u(t) - 2e^{-2t}\,u(t) + e^{-4t}\,u(t)$$

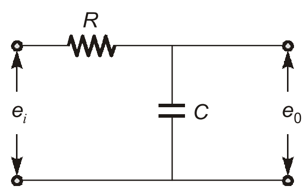
$$= (1 - 2e^{-2t} + e^{-4t})u(t)$$

7. (d)

Over all transfer function

$$= \frac{G_1G_2}{1+G_1G_2H_1+G_2H_1}$$

8. (a)



$$\frac{e_o}{e_i} = \frac{\frac{1}{CS}}{R+\frac{1}{CS}} = \frac{1}{RCS}$$

9. (d)

The value of $f(s) = \frac{2}{s^2+3}$ at $t = 0$

$$\lim_{s\to\infty} s\left(\frac{2}{s^2+3}\right) = \lim_{s\to\infty} \frac{2s}{s^2+3} = 0$$

10. (d)

The initial slope at the Bode plot gives type of the system.

11. (c)

The value of k at which the root locus crosses the imaginary axis, make the system marginally stable.

12. (b)

Given characteristics $s^3 + 2s^2 + ks + k = 0$ equation

$$\frac{C(s)}{R(s)} = \frac{k(s+1)}{s^3+2s^2}$$

Number of poles = 3

Number of zeros = 1

$$\sigma = -\frac{2+1}{2} = -0.5$$

13. (b)

Given, $G(s) = \frac{s+6}{ks^2+s+6}$

Damping ratio = 1

Characteristics equation

$$= ks^2 + s + 6 + s + 6$$
$$= ks^2 + 2s + 12$$
$$= s^2 + \frac{2}{k}s + \frac{12}{k}$$

$$\omega_n = \sqrt{\frac{12}{k}}$$

$$2\xi\omega_n = \frac{2}{k}$$

$$k = \frac{1}{12}$$

15. (a)

Given transfer function,

$$\frac{Y(s)}{U(s)} = \frac{2}{s^3+6s^2+11s+6}$$

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\0\\1\end{bmatrix}U$$

$$y = [0 \quad 0 \quad 2]\,[x]$$

$$A = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}$$

$$B = \begin{bmatrix}0\\0\\1\end{bmatrix}[0 \;\; 0 \;\; 2]$$

for controllability: $\begin{bmatrix}B & AB & A^2B\end{bmatrix}$

$$C_T = \begin{bmatrix}0 & 0 & 1\\ 0 & 1 & 6\\ 1 & -6 & 102\end{bmatrix} = \text{dat}\, C_T$$

Hence, controllable.

$|C_T| \neq 0$ controllable

For observability : $\begin{bmatrix}C\\ CA\\ CA^2\end{bmatrix} = \begin{matrix} & 0 & 2\\ 2 & 2 & 0\\ 0 & 12 & 2\end{matrix}$

$|0| \neq 0$ Hence, observable

16. (d)

Output for a unit step input is $t^2 \cdot e^{-t}$

$$Y(t) = t^2 \cdot e^{-t}$$

$$Y(s) = \frac{2}{(s+1)^3}$$

$$X(s) = \frac{1}{s}$$

$$\frac{Y(s)}{X(s)} = \frac{2s}{(s+1)^3}$$

17. (b)

$$20 \log k = 6 \text{ db}$$

$$\log k = \frac{3}{10}$$

$$\Rightarrow \quad 10^{0.3} = k$$

$$T(s) = \frac{20s}{(s+1)(s+10)}$$

18. (d)

Non-minimum phase system transfer function has its zero in the right half of the s-plane.

19. (c)

Given transfer function,

$$G(s) = \frac{1+6s}{1+2s}$$

$$G(s) = \frac{6\left(s+\frac{1}{6}\right)}{2\left(s+\frac{1}{2}\right)} = \frac{3\left(s+\frac{1}{6}\right)}{\left(s+\frac{1}{2}\right)}$$

$$a = \frac{P_c}{z_c} = \frac{1/2}{1/6} = 3$$

Maximum phase shift = $\sin^{-1}\left(\frac{3-1}{3+1}\right) = 30°$

21. (d)

$$u(t-T_1) - u(t-T_2)$$

$$\frac{e^{-ST_1}}{S^2} - \frac{e^{-ST_2}}{S^2}$$

22. (a)

For a 4^{th} or der all pole system slope (–20 db) × 4 = –80 db/decade.

24. (d)

We will use a band to 5% although sometimes 2% are also used.

25. (b)

Using C.E. : $s^2 + 2\xi\omega_n s + \omega_n^2$

$\omega_n^2 = 9, \quad \omega_n = 3$ rad/sec

26. (d)

This is done by calculating the vertical distance between the phase curve (on the bode phase plot) and the x-axis at the frequency where the bode magnitude plot = 0 dB. This point is known as the gain crossover frequency.

27. (b)

This is unstable system, therefore GM as well as PM is (–)ve.

28. (d)

All of the above mentioned signal i.e. impulse, ramp and unit step are used to test dynamic behaviour of control system.

29. (b)

Given transfer function = $\frac{16}{(s^2+4s+16)}$

The standard second order expression in terms of damping ratio (ξ) and natural frequency (ω_n) is as follows

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$$

Therefore, natural frequency $\omega_n = 4$ rad/sec
Damping ratio $\xi = 0.5$

Setting time for 2% tolerance = $\frac{4}{\xi\omega_n}$

$$= \frac{4}{4 \times 0.5} = 2 \text{ sec}$$

30. (c)

Number of state required for network with *n* energy storing elements is *n*.

∴ For 2 degree equation minimum states required is 2.

31. (a)

Fault current,

$$I_f = \frac{3E_a}{Z_1 + Z_2 + Z_0}$$

$$= \frac{3 \times 1}{j0.25 + j0.25 + j0.15 + j0.15}$$

$$= \frac{3}{j0.80} = -j\,3.75 \text{ pu}$$

32. (c)

If a voltage control bus has its reactive power limits violated, then that bus will be treated as a load bus.

33. (d)

Zero voltage regulation is possible only for leading power factor.

34. (d)

$$B = \frac{\mu_0}{4\pi}\frac{2I}{r}$$

where $H = \frac{2I}{4\pi r}$

35. (d)

Sequence impedances of a transmission line

$$Z_1 = Z_2 = x_s - x_m$$
$$Z_0 = x_s + 2x_m$$
$$\therefore \quad Z_1 = Z_2 < Z_0$$

36. (a)

Circular.

37. (c)

The most common conductor in use for transmission today is aluminum conductor steel rein forced (ACSR).

38. (c)

The Kelvin's law states that the most economical size of a conductor is that for which annual interest and depreciation on the capital cost of the conductor is equal to the annual cost of energy loss.

40. (a)

Types of insulators

1. Pin - type insulator
2. Suspension - type insulator
3. Strain-type insulator

41. (a)

The Bipolar link has two conductors one is positive and the other one is negative to the Earth.

42. (b)

For $(m \times m)$ bus if the added element is a branch then the new bus impedance matrix will be of dimensions $(m + 1) \times (m + 1)$.

43. (a)

Good voltage regulation of a distribution network is probably the most important factor responsible for delivering good service to the consumers.

44. (b)

The non-uniform distribution of electric current over the surface on skin of the conductor carrying a.c in called the skin effect.

45. (b)

In ac transmission system, when we are increasing the inductance of the line, power factor reduces, impedance increases and hence delivered power reduces. So we can say that transmission capacity of the line is inversely proportional to the line.

47. (d)

The relay current (rated) is 5A. If the relay setting is 50%, then the relay can be operated for $5 \times \frac{50}{100} = 2.5$ A. We know that the fault current is 2000 A. Hence the fault current in the secondary of the CT is $5 \times \left(\frac{2000}{400}\right) = 25$ Amps. hence, the plug setting multiplier

$$= \frac{25}{2.5} = 10$$

50. (a)

$$Z_{(pu)new} = Z_{(pu)old} \times \frac{(MVA)_{bnew}}{(MVA)_{bold}} \times \frac{(kV)^2_{bold}}{(kV)^2_{bnew}}$$

$$= 0.242 \times \frac{1}{(1.1)^2} = 0.200$$

52. (d)

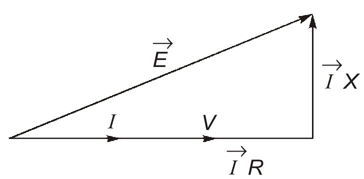
Leakage resistance of the cable $\propto \frac{1}{\text{Length}}$

For 100 km long cable leakage resistance of cable

$$= \frac{50}{100} = 0.5\ \text{M}\Omega$$

53. (c)

At unit power factor



$$I = \frac{1000 \times 10^3}{2000} = 500\ \text{A}$$

$$|V + IR| = 2000 + 500 \times 1.4 = 2700\ \text{V}$$

$$|IX| = 500 \times 0.8 = 400\ \text{V}$$

$$E = \sqrt{(V + IR)^2 + (IX)^2}$$

$$= \sqrt{7450000} = 2729.468\ \text{V}$$

55. (b)

The voltage reflection coefficient is –1 for a short circuited line.

56. (a)

Method of improving string efficiency

(i) Using longer cross arms

(ii) Grading of insulator discs

(iii) By using a guard or grading ring

58. (*)

$$SH = S_1H_1 + S_2H_2$$

$$100\ H = 250 \times 1.6 + 500 \times 1$$

$$H = \frac{900}{100} = 9$$

Given solution is correct, no option matching.

59. (a)

$$D_S^b = \sqrt{(D_S \times d)}$$

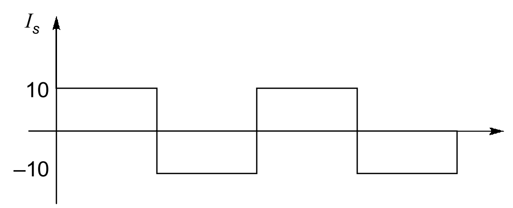
60. (c)

In a power system PQ bus constitute maximum number in a power system

61. (d)

It is not possible to have finite no-load speed in dc series motor.

62. (d)



$$I_{s(avg)} = 0\ \text{A}$$

$$I_{s(rms)} = 10$$

64. (d)

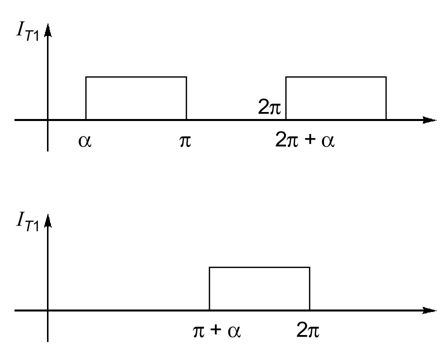
Pulse transformer is used to isolate gate triggering circuit from high power main circuit.

65. (b)

$$\frac{T_{Y-\Delta}}{T_{DOL}} = \frac{1}{3}$$

$$T_{Y-\Delta} = \frac{1}{3} \times 600 = 200\ \text{Nm}$$

66. (d)



Each SCR conducts for $= 2\pi - (\pi + \alpha)$

$$= \pi - \alpha$$