Fully Solved

3200 MCQs

For

GATE & PSUs

Instrumentation Engineering

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3200 Multiple Choice Questions for GATE and PSUs : Instrumentation Engineering

First Edition: 2018
Reprint: 2020
Reprint: 2022
Reprint: 2023
Reprint: 2024

Published by: MADE EASY Publications, New Delhi-110016

PREFACE

B. Singh (Ex. IES)

It gives me great happiness to introduce the **First Edition** on Instrumentation Engineering containing nearly 3200 MCQs which focuses in-depth understanding of subjects which has been segregated topicwise to disseminate all kind of exposure to students in terms of quick learning and deep apt. The topicwise segregation has been done to align with contemporary competitive examination pattern. Attempt has been made to bring out all kind of probable competitive questions for the aspirants preparing for GATE and PSUs. The content of this book ensures threshold level of learning and wide range of practice questions which is very much essential to boost the exam time confidence level and ultimately to succeed in all prestigious engineers' examinations. It has been ensured from MADE EASY team to have broad coverage of subjects at chapter level.

While preparing this book utmost care has been taken to cover all the chapters and variety of concepts which may be asked in the exams. The solutions and answers provided are upto the closest possible accuracy. The full efforts have been made by MADE EASY Team to provide error free solutions and explanations.

I have true desire to serve student community by way of providing good sources of study and quality guidance. I hope, this book will be proved an important tool to succeed in competitive examinations. Any suggestions from the readers for the improvement of this book are most welcome.

B. Singh (Ex. IES)
Chairman and Managing Director
MADE EASY Group

Instrumentation Engineering : GATE Syllabus

1. **Engineering Mathematics:** (i) Linear Algebra: Matrix algebra, systems of linear equations, Eigen values and Eigen vectors. (ii) Calculus: Mean value theorems, theorems of integral calculus, partial derivatives, maxima and minima, multiple integrals, Fourier series, vector identities, line, surface and volume integrals, Stokes, Gauss and Green's theorems. (iii) Differential equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of parameters, Cauchy's and Euler's equations, initial and boundary value problems, solution of partial differential equations: variable separable method. (iv) Analysis of complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent's series, residue theorem, solution of integrals. (v) Probability and Statistics: Sampling theorems, conditional probability, mean, median, mode and standard deviation, random variables, discrete and continuous distributions: normal, Poisson and binomial distributions. (vi) Numerical Methods: Matrix inversion, solutions of non-linear algebraic equations, iterative methods for solving

2. **Electrical Circuits:** Voltage and current sources: independent, dependent, ideal and practical; v-i relationships of resistor, inductor, mutual inductor and capacitor; transient analysis of RLC circuits with dc excitation. Kirchoff's laws, mesh and nodal analysis, superposition, Thevenin, Norton, maximum power transfer and reciprocity theorems. Peak-, average- and rms values of ac quantities; apparent-, active- and reactive powers; phasor analysis, impedance and admittance; series and parallel resonance, locus diagrams, realization of basic filters with R, L and C elements. One-port and two-port networks, driving point impedance and admittance, open-, and short circuit parameters.

3. **Signals and Systems:** Periodic, aperiodic and impulse signals; Laplace, Fourier and z-transforms; transfer function, frequency response of first and second order linear time invariant systems, impulse response of systems; convolution, correlation. Discrete time system: impulse response, frequency response, pulse transfer function; DFT and FFT; basics of IIR and FIR filters.

4. **Control Systems:** Feedback principles, signal flow graphs, transient response, steady-state-errors, Bode plot, phase and gain margins, Routh and Nyquist criteria, root loci, design of lead, lag and lead-lag compensators, state-space representation of systems; time-delay systems; mechanical, hydraulic and pneumatic system components, synchro pair, servo and stepper motors, servo valves; on-off, P, P-I, P-I-D, cascade, feedforward, and ratio controllers.

5. **Analog Electronics:** Characteristics and applications of diode, Zener diode, BJT and MOSFET; small signal analysis of transistor circuits, feedback amplifiers. Characteristics of operational amplifiers; applications of opamps: difference amplifier, adder, subtractor, integrator, differentiator, instrumentation amplifier, precision rectifier, active filters and other circuits. Oscillators, signal generators, voltage controlled oscillators and phase locked loop.

6. **Digital Electronics:** Combinational logic circuits, minimization of Boolean functions. IC families: TTL and CMOS. Arithmetic circuits, comparators, Schmitt trigger, multi-vibrators, sequential circuits, flip-flops, shift registers, timers and counters; sample-and-hold circuit, multiplexer, analog-to-digital (successive approximation, integrating, flash and sigma-delta) and digital-to-analog converters (weighted R, R-2R ladder and current steering logic). Characteristics of ADC and DAC (resolution, quantization, significant bits, conversion/settling time); basics of number systems, 8-bit microprocessor and microcontroller: applications, memory and input-output interfacing; basics of data acquisition systems.

7. **Measurements:** SI units, systematic and random errors in measurement, expression of uncertainty - accuracy and precision index, propagation of errors. PMMC, MI and dynamometer type instruments; dc potentiometer; bridges for measurement of R, L and C, Q-meter. Measurement of voltage, current and power in single and three phase circuits; ac and dc current probes; true rms meters, voltage and current scaling, instrument transformers, timer/counter, time, phase and frequency measurements, digital voltmeter, digital multimeter; oscilloscope, shielding and grounding.

8. **Sensors and Industrial Instrumentation:** Resistive-, capacitive-, inductive-, piezoelectric-, Hall effect sensors and associated signal conditioning circuits; transducers for industrial instrumentation: displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure (including low pressure), flow (differential pressure, variable area, electromagnetic, ultrasonic, turbine and open channel flow meters) temperature (thermocouple, bolometer, RTD (3/4 wire), thermistor, pyrometer and semiconductor); liquid level, pH, conductivity and viscosity measurement.

9. **Communication and Optical Instrumentation:** Amplitude- and frequency modulation and demodulation; Shannon's sampling theorem, pulse code modulation; frequency and time division multiplexing, amplitude-, phase-, frequency-, pulse shift keying for digital modulation; optical sources and detectors: LED, laser, photo-diode, light dependent resistor and their characteristics; interferometer: applications in metrology; basics of fiber optic sensing.

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CONTENTS

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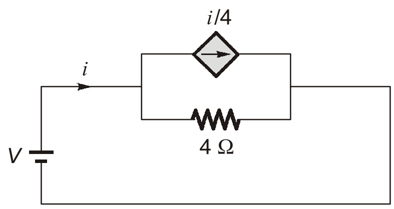
UNIT 1

Electrical Circuits

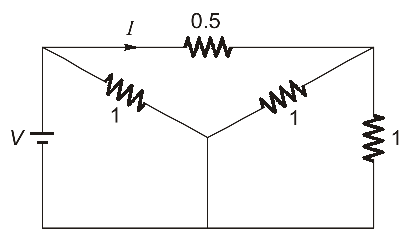
1. Basic of Network Analysis

Q.1 In the network shown below, the effective resistance faced by the voltage source is



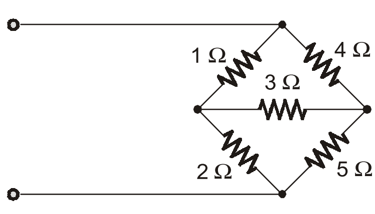
(a) 4 Ω (b) 3 Ω
(c) 2 Ω (d) 1 Ω

Q.2 In the circuit shown in the figure, if I = 2 A, then the value of the battery voltage V will be



(a) 5 V (b) 3 V
(c) 2 V (d) 1 V

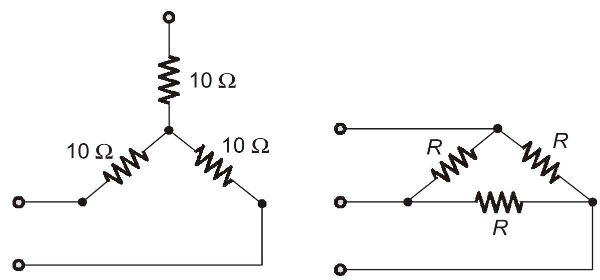
Q.3 The input resistance of the circuit shown is



(a) 1 Ω (b) 3.36 Ω
(c) 2.24 Ω (d) 1.12 Ω

Q.4 In a network made up of linear resistors and ideal voltage sources, values of all resistors are doubled. Then the voltage across each resistor is
(a) Doubled
(b) Halved
(c) Decreased four times
(d) Not changed

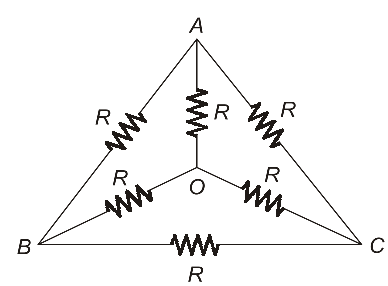
Q.5 Star connected load is shown in the figure. The equivalent delta connection has a value of R in Ω is



(a) 10 Ω (b) 30 Ω
(c) 10/3 Ω (d) 20/3 Ω

Q.6 Kirchhoff's current law is valid for
(a) DC circuit only
(b) AC circuit only
(c) Both DC and AC circuits
(d) Sinusoidal source only

Q.7 The effective resistance between the terminals A and B in the circuit shown in the figure is



(a) R (b) $R - 1$
(c) $R/2$ (d) $6R/11$

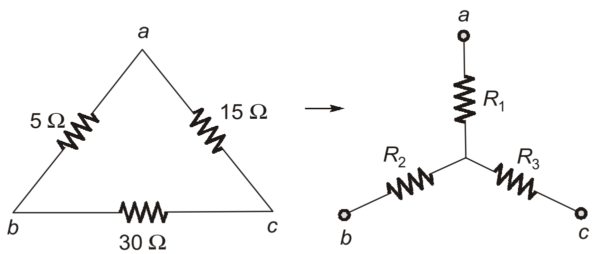
Q.8 The nodal method of circuit analysis is based on
(a) KVL and Ohm's law
(b) KCL and Ohm's law
(c) KCL and KVL
(d) KCL and KVL and Ohm's law

Q.9 Twelve 1 Ω resistances are used as edge to form a cube. The resistance between two diagonally opposite corners of the cube is

(a) $\frac{5}{6}\Omega$ (b) $1\ \Omega$

(c) $\frac{6}{5}\Omega$ (d) $\frac{3}{2}\Omega$

Q.10 A delta connected network with its Y-equivalent is shown in figure. The resistances R_1, R_2 and R_3 (in ohms) are respectively



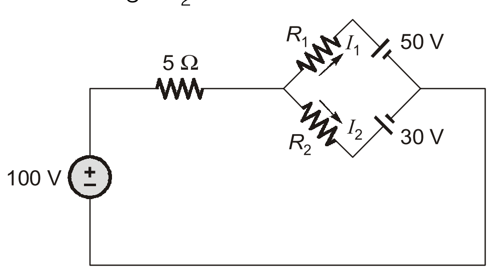
(a) 1.5 Ω, 3 Ω and 9 Ω
(b) 3 Ω, 9 Ω and 1.5 Ω
(c) 9 Ω, 3 Ω and 1.5 Ω
(d) 3 Ω, 1.5 Ω and 9 Ω

Q.11 If each branch of a delta circuit has impedance $\sqrt{3}\ Z$, then each branch of equivalent Y-circuit has impedance

(a) $\frac{Z}{\sqrt{3}}$ (b) Z

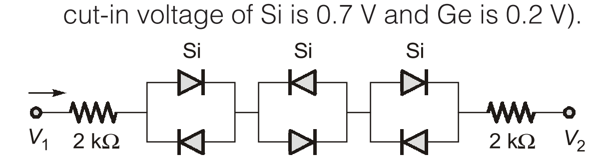
(c) $2\sqrt{3}\ Z$ (d) $\frac{Z}{3}$

Q.12 In the circuit shown, what are the values of R_1 and R_2 when the current flowing through R_1 is 1 A and through R_2 is 5 A?



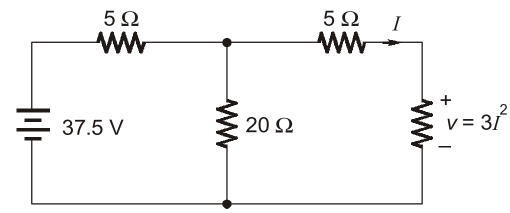
(a) 20 Ω, 8 Ω (b) 12 Ω, 5 Ω
(c) 8 Ω, 12 Ω (d) 8 Ω, 20 Ω

Q.13 Determine the current in the network (Assume cut-in voltage of Si is 0.7 V and Ge is 0.2 V).



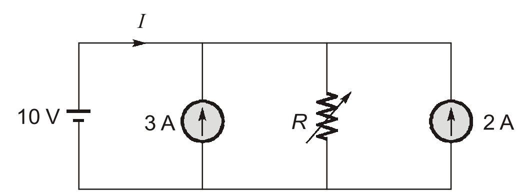
(a) 1.6 mA (b) 1.575 mA
(c) 1.557 mA (d) None of these

Q.14 The value of 'I' in the circuit given below is



(a) –5 A (b) 5 A
(c) –2 A (d) 2 A

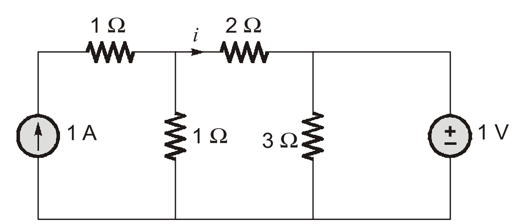
Q.15 Consider the electrical network shown below.



What is the value of R so that current I is zero?

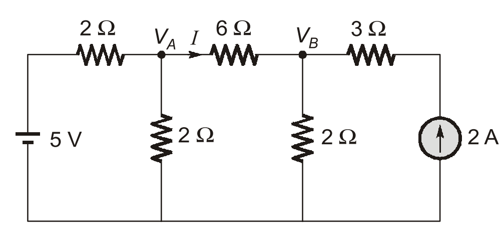
(a) 2 Ω (b) 5 Ω
(c) 4 Ω (d) 3 Ω

Q.16 The current i in the network given below is



(a) 1 A (b) 2 A
(c) 3 A (d) 0 A

Q.17 Node voltages V_A and V_B are as shown in the circuit below



V_A and V_B are respectively

(a) $\frac{11}{3}$ V and $\frac{8}{3}$ V (b) 6 V and 8 V

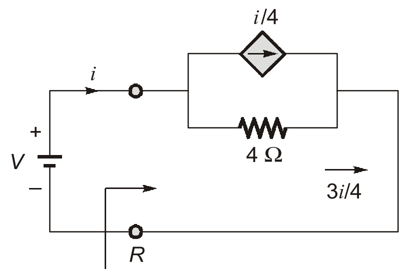
(c) $\frac{24}{9}$ V and $\frac{33}{9}$ V (d) None of these

Answers Electrical Circuits

1.	(b)	2.	(c)	3.	(c)	4.	(d)	5.	(b)	6.	(c)	7.	(c)	8.	(b)
9.	(a)	10.	(a)	11.	(a)	12.	(a)	13.	(b)	14.	(d)	15.	(a)	16.	(d)
17.	(c)	18.	(c)	19.	(c)	20.	(b)	21.	(d)	22.	(c)	23.	(a)	24.	(d)
25.	(a)	26.	(a)	27.	(c)	28.	(d)	29.	(d)	30.	(d)	31.	(d)	32.	(d)
33.	(d)	34.	(a)	35.	(a)	36.	(b)	37.	(c)	38.	(c)	39.	(c)	40.	(b)
41.	(d)	42.	(c)	43.	(a)	44.	(d)	45.	(d)	46.	(a)	47.	(d)	48.	(d)
49.	(b)	50.	(a)	51.	(c)	52.	(a)	53.	(d)	54.	(d)	55.	(a)	56.	(d)
57.	(c)	58.	(d)	59.	(a)	60.	(c)	61.	(d)	62.	(c)	63.	(d)	64.	(b)
65.	(c)	66.	(a)	67.	(c)	68.	(b)	69.	(c)	70.	(a)	71.	(a)	72.	(c)
73.	(c)	74.	(c)	75.	(b)	76.	(d)	77.	(d)	78.	(d)	79.	(a)	80.	(b)
81.	(c)	82.	(d)	83.	(b)	84.	(c)	85.	(d)	86.	(a)	87.	(c)	88.	(d)
89.	(d)	90.	(c)	91.	(b)	92.	(b)	93.	(d)	94.	(c)	95.	(b)	96.	(b)
97.	(d)	98.	(c)	99.	(c)	100.	(d)	101.	(b)	102.	(c)	103.	(d)	104.	(d)
105.	(a)	106.	(c)	107.	(b)	108.	(b)	109.	(c)	110.	(c)	111.	(a)	112.	(c)
113.	(c)	114.	(b)	115.	(a)	116.	(b)	117.	(a)	118.	(b)	119.	(c)	120.	(a)
121.	(c)	122.	(d)	123.	(c)	124.	(b)	125.	(a)	126.	(a)	127.	(d)	128.	(d)
129.	(d)	130.	(b)	131.	(b)	132.	(b)	133.	(c)	134.	(d)	135.	(d)	136.	(c)
137.	(c)	138.	(b)	139.	(c)	140.	(d)	141.	(d)	142.	(c)	143.	(b)	144.	(b)
145.	(b)	146.	(a)	147.	(a)	148.	(d)	149.	(c)	150.	(b)	151.	(c)	152.	(c)
153.	(b)	154.	(c)	155.	(a)	156.	(b)	157.	(c)	158.	(a)	159.	(b)	160.	(d)
161.	(a)	162.	(c)	163.	(b)	164.	(d)	165.	(c)	166.	(c)	167.	(b)	168.	(d)
169.	(c)	170.	(c)	171.	(a)	172.	(c)	173.	(c)	174.	(c)	175.	(d)	176.	(b)
177.	(b)	178.	(c)	179.	(b)	180.	(d)	181.	(a)	182.	(c)	183.	(d)	184.	(c)
185.	(d)	186.	(b)	187.	(c)	188.	(a)	189.	(c)	190.	(b)	191.	(a)	192.	(c)
193.	(c)	194.	(c)	195.	(b)	196.	(d)	197.	(b)	198.	(c)	199.	(a)	200.	(c)
201.	(b)	202.	(c)	203.	(c)	204.	(c)	205.	(c)	206.	(a)	207.	(b)	208.	(d)
209.	(a)	210.	(b)	211.	(a)	212.	(a)	213.	(a)	214.	(b)	215.	(b)	216.	(d)
217.	(d)	218.	(b)	219.	(c)	220.	(d)	221.	(a)	222.	(d)	223.	(c)	224.	(d)
225.	(b)	226.	(a)	227.	(d)	228.	(b)	229.	(a)	230.	(d)	231.	(d)	232.	(a)
233.	(a)	234.	(d)	235.	(d)	236.	(b)	237.	(b)	238.	(d)	239.	(a)	240.	(d)
241.	(d)	242.	(b)	243.	(a)	244.	(c)	245.	(b)	246.	(c)	247.	(c)	248.	(a)
249.	(a)	250.	(c)	251.	(d)	252.	(c)	253.	(b)	254.	(c)	255.	(d)	256.	(d)
257.	(a)	258.	(b)	259.	(a)	260.	(a)	261.	(c)	262.	(c)	263.	(c)	264.	(d)
265.	(c)	266.	(b)	267.	(b)	268.	(b)	269.	(c)	270.	(b)	271.	(d)	272.	(a)
273.	(d)	274.	(d)	275.	(c)	276.	(b)	277.	(a)	278.	(c)	279.	(c)	280.	(b)
281.	(b)	282.	(a)	283.	(a)	284.	(c)								

Explanations

1. (b)



$$R = \frac{V}{i}$$

Using source transformation and KVL, we get,

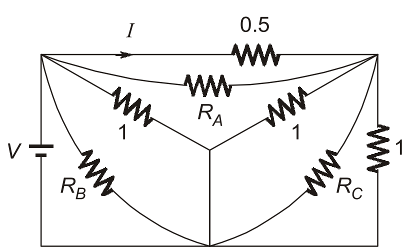
$$V + i = 4i$$

or, $$V = 3i$$

$$\Rightarrow \quad R = \frac{V}{i} = 3\ \Omega$$

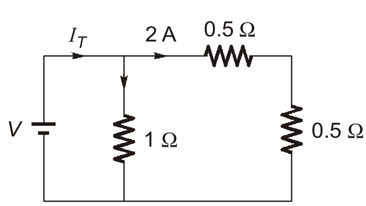
2. (c)

Given circuit:



Y-Δ transforming

$$R_A = \infty$$
$$R_B = 1\ \Omega$$
$$R_C = 1\ \Omega$$

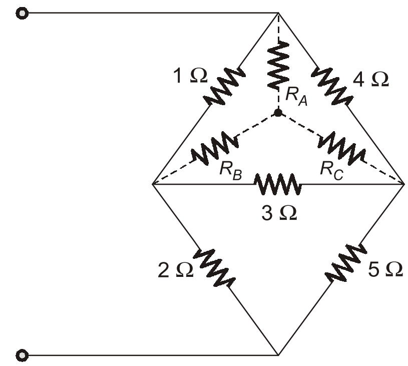


By current division rule

$$I_T = 2 \times 2 = 4\text{ A.}$$

$$\because \quad V = I_T \times R = 4 \times 0.5 = 2\text{ V}$$

3. (c)



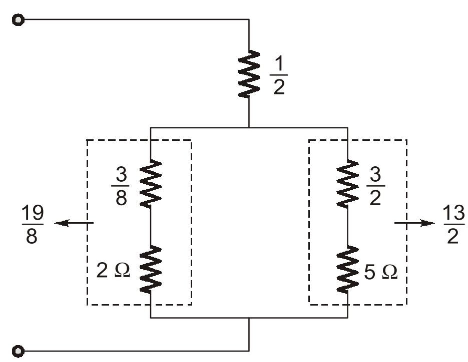
Δ-Y conversion:

$$R_A = \frac{4}{8} = \frac{1}{2}$$

$$R_B = \frac{3}{8}\ \Omega$$

$$R_C = \frac{12}{8}\ \Omega = \frac{3}{2}$$

Redrawing the circuit,



$$R_{in} = \frac{1}{2} + \left(\frac{19}{8} \parallel \frac{13}{2}\right)$$

$$R_{in} = 2.24\ \Omega$$

4. (d)

Ideal voltage source keeps the terminal voltage constant so accordingly current will change and the voltage across each resistor is unchanged following superposition principle.

5. (b)

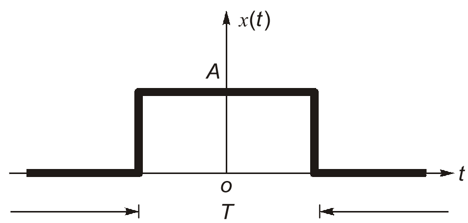
$$R = \frac{1}{10}[(10 \times 10) + (10 \times 10) + (10 \times 10)] = 30$$

UNIT 2

Signals and Systems

1. Basic of Signal and Systems

Q.1 What is the total energy of the rectangular pulse shown in figure below?



(a) AT (b) A^2T
(c) A^2T^2 (d) AT^2

Q.2 Which one of the following is the impulse response of the system whose step response is given as $c(t) = 0.5(1 - e^{-2t})\, u(t)$?
(a) $e^{-2t}\,u(t)$ (b) $0.5\,\delta(t) + e^{-2t}u(t)$
(c) $0.5\,e^{-2t}\,u(t)$ (d) $0.5\,\delta(t) - 0.5\,e^{-2t}u(t)$

Q.3 A system with an input $x(t)$ and output $y(t)$ is described by the relation: $y(t) = tx(t)$. This system is
(a) Linear and time-invariant
(b) Linear and time varying
(c) None-linear and time invariant
(d) Non-linear and time varying

Q.4 The signal $x(t) = A\cos(\omega t + \phi)$ is
(a) an energy signal
(b) a power signal
(c) an energy as well as a power signal
(d) Neither an energy nor a power signal

Q.5 The system $y(t) = tx(t) + 4$ is
(a) non-linear, time-varying and unstable
(b) linear, time-varying and unstable
(c) non-linear, time invariant and unstable
(d) non-linear, time-varying and stable

Q.6 The signal $x(t)$ is a real and odd function of 't' the $x(\omega)$ is
(a) a real and even function of ω
(b) an imaginary and odd function of ω
(c) an imaginary and even function of ω
(d) a real and odd function of ω

Q.7 The discrete time system described by $y(n) = x(n^2)$, is
(a) Causal, linear and time varying
(b) Causal, linear and time invariant
(c) Non causal, linear and time varying
(d) Non causal, linear and time invariant

Q.8 What is the power and energy of the unit step sequence $u(n)$ respectively:
(a) ∞, 0 (b) 0, ∞
(c) $\frac{1}{2}$, 0 (d) $\frac{1}{2}$, ∞

Q.9 The discrete time signal is defined by

$$x(n) = \begin{cases} 1, & n = 1 \\ -1, & n = -1 \\ 0, & n = 0 \text{ and } |n| > | \end{cases}$$

If, $y(n)$ defined by $y(n) = x(n) + x(-n)$, then the value of $y(n)$ is
(a) 0 (b) 1
(c) 2 (d) ∞

Q.10 In memoryless system
(a) zero state response is zero
(b) zero input response is zero
(c) both response are zero
(d) both response are finite

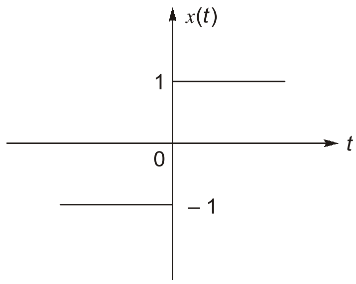
Q.11 Let $\delta(t)$ is the delta function the value of integral

$$\int_{-\infty}^{+\infty} \delta(t)\cos\left(\frac{3t}{2}\right) dt \text{ is}$$

(a) 1 (b) -1
(c) 0 (d) $\frac{\pi}{2}$

Q.12 If a signal $f(t)$ has energy 'E' the energy of the signal $f(2t)$ is equal to
(a) E (b) $\frac{E}{2}$
(c) $2E$ (d) $4E$

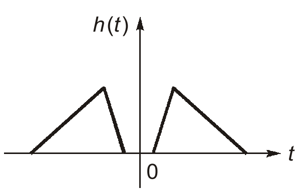
Q.13 The function $x(t)$ is shown in the figure. Even and odd parts of a unit step function $u(t)$ are respectively

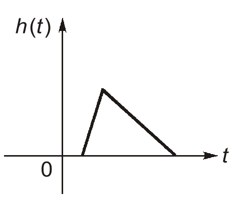


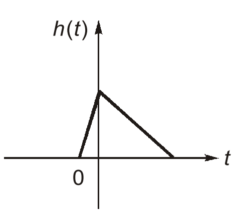
(a) $\frac{1}{2}, \frac{1}{2}x(t)$ (b) $-\frac{1}{2}, \frac{1}{2}x(t)$

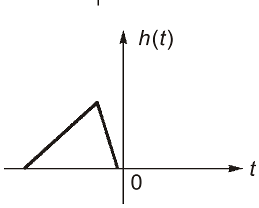
(c) $\frac{1}{2}, -\frac{1}{2}x(t)$ (d) $-\frac{1}{2}, -\frac{1}{2}x(t)$

Q.14 Which of the following can be impulse response of causal system?

(a)


(b)


(c)


(d)


Q.15 The power in the signal,

$S(t) = 8\cos\left(20\pi t - \frac{\pi}{2}\right) + 4\sin(15\pi t)$ is

(a) 40 (b) 41

(c) 42 (d) 82

Q.16 The dirac delta function $\delta(t)$ is defined as

(a) $\delta(t) = \begin{cases} 1 \ ; & t = 0 \\ 0 \ ; & \text{otherwise} \end{cases}$

(b) $\delta(t) = \begin{cases} \infty \ ; & t = 0 \\ 0 \ ; & \text{otherwise} \end{cases}$

(c) $\delta(t) = \begin{cases} 1 \ ; & t = 0 \\ 0 \ ; & \text{otherwise} \end{cases}$ and $\int_{-\infty}^{\infty} \delta(t)dt = 1$

(d) $\delta(t) = \begin{cases} \infty \ ; & t = 0 \\ 0 \ ; & \text{otherwise} \end{cases}$ and $\int_{-\infty}^{\infty} \delta(t)dt = 1$

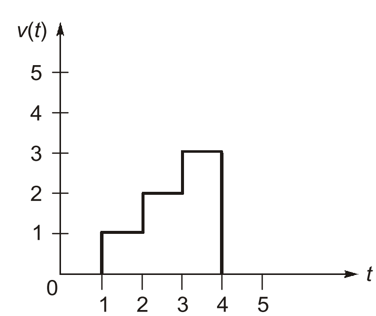
Q.17 A system with input $x[n]$ and output $y[n]$ is given as $y[n] = \left(\sin\frac{5}{6}\pi n\right) \cdot x[n]$. The system is

(a) linear, stable and invertible
(b) non-linear, stable and non-invertible
(c) linear, stable and non-invertible
(d) linear, unstable and invertible

Q.18 Which of the following is false statement?

(a) $t\delta(t) = 0$
(b) $\cos t \cdot \delta(t - \pi) = -\delta(t - \pi)$
(c) $\delta(t) = \int u(t)\, dt$
(d) $t\delta'(t) = \delta(t)$

Q.19 Consider the voltage wave form shown in below figure the equation for $v(t)$ is



(a) $u(t-1) + u(t-2) + u(t-3)$
(b) $u(t-1) + 2\,u(t-2) + 3\,u(t-3)$
(c) $u(t-1) + u(t-2) + u(t-3) + u(t-4)$
(d) $u(t-1) + u(t-2) + u(t-3) - 3u(t-4)$

Q.20 A signal is described by $x(t) = r(t-4) - r(t-6)$. Where $r(t)$ is a unit ramp function starting at $t = 0$. The signal $x(t)$ is represented as.

Answers Signals and Systems

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

Explanations

1. (b)

The energy of rectangular pulse is given by,

$$E = \int_{-T/2}^{T/2} A^2 dt = A^2 T$$

2. (a)

Impulse response of the system $= \frac{d}{dt}c(t)$

Where, $c(t)$ = Step response

$$h(t) = \frac{d}{dt}0.5(1-e^{-2t})$$

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

3. (b)

$$y(t) = tx(t)$$

$$ax_1(t) \rightarrow atx_1(t)$$

$$x_2(t) \rightarrow btx_2(t)$$

$$ax_1(t) + bx_2(t) \rightarrow t[ax_1(t)+bx_2(t)]$$

$$= atx_1(t) + btx_2(t)$$

Satisfy principle of superposition and homogeneity. So, linear function

$$y(t-\tau) = (t-\tau)\,x(t-\tau) \quad \text{...(i)}$$

$$x(t-\tau) \xrightarrow{R} tx(t-\tau) \quad \text{...(ii)}$$

(1) ≠ (2) ⇒ Time varying system

4. (b)

$$x(t) = A\cos(\omega t+\phi)$$

$t \rightarrow \infty$, $x(t)$ = Finite value

$$P[x(t)] = \frac{A^2}{2} \Rightarrow \text{Power signal}$$

5. (a)

Given system is $y(t) = tx(t) + 4$

$$ax_1(t) \xrightarrow{R} atx_1(t) + 4 \quad \text{...(i)}$$

$$bx_2(t) \xrightarrow{R} btx_2(t) + 4 \quad \text{...(ii)}$$

$$ax_1(t) + bx_2(t) \xrightarrow{R} [ax_1(t)+bx_2(t)]+4 \quad \text{...(iii)}$$

Equation (i) + (ii) ≠ (iii) ⇒ Non-linear system.

$$y(t-\tau) = (t-\tau)\,x(t-\tau) + 4 \quad \text{...(iv)}$$

$$x(t-\tau) \xrightarrow{R} tx(t-\tau) + 4 \quad \text{...(v)}$$

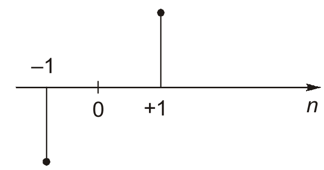
Equation (iv) ≠ (v) ⇒ Time varying system

$t \rightarrow \infty$ for bounded input, output is not bounded

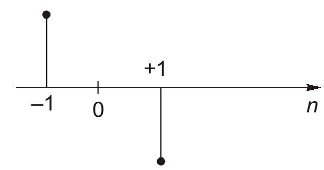
⇒ Unstable system.

9. (a)

$x(n) =$



$x(-n) =$



$$x(n) + x(-n) = 0$$

11. (a)

$$\int_{-\infty}^{\infty} \delta(t)\,f(t)\,dt = f(0)$$

$$\Rightarrow \int_{-\infty}^{\infty} \delta(t)\cos\left(\frac{3t}{2}\right) = 1$$

12. (b)

$$E = \int_{-\infty}^{\infty} f(t)^2\,dt$$

and $$E^1 = \int_{-\infty}^{\infty} f(2t)^2\,dt = \int_{-\infty}^{\infty} f(p)^2\,dp.\frac{1}{2}$$

$$\left[\begin{array}{l} \therefore 2t = p \\ dt = dp\cdot\frac{1}{2} \end{array}\right]$$

$$\Rightarrow \quad E^1 = \frac{E}{2}$$

14. (b)

For causal system output depends on the past and present value.

$$h(t) = tu(t-t_1) - tu(t-t_2)$$

15. (a)

$$S(t) = 8\cos\left(\frac{\pi}{2} - 20\pi t\right) + 4\sin 15\pi t$$

$$= 8\sin 20\pi t + 4\sin 15\pi t$$

$$\Rightarrow \quad P = \frac{8^2}{2} + \frac{4^2}{2} = 32 + 8 = 40$$

UNIT 3

Control Systems and Process Control

1. Block Diagram and Signal Flow Graph

Q.1 The impulse response of an initially relaxed linear system is $e^{-2t}\,u(t)$. To produce a response of $te^{-2t}\,u(t)$, the input must be equal to

(a) $2e^{-t}\,u(t)$ (b) $\frac{1}{2}e^{-2t}\,u(t)$

(c) $e^{-2t}\,u(t)$ (d) $e^{-t}\,u(t)$

Q.2 As compared to closed loop system, an open loop is

(a) more stable as well as more accurate
(b) less stable as well as less accurate
(c) more stable but less accurate
(d) less stable but more accurate

Q.3 Signal flow graph is used to find

(a) Stability of the system
(b) Controllability of the system
(c) Transfer function of the system
(d) Poles of the system

Q.4 The transfer function of the system is $\dfrac{2s^2+6s+5}{(s+1)^2\,(s+2)}$, the characteristic equation of the system is

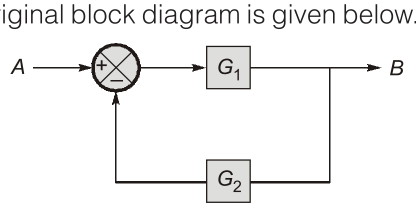
(a) $2s^2 + 6s + 5 = 0$
(b) $(s + 1)^2\,(s + 2) = 0$
(c) $2s^2 + 6s + 5 + (s + 1)^2\,(s + 2) = 0$
(d) $2s^2 + 6s + 5\,(s + 1)^2\,(s + 2) = 0$

Q.5 With negative feedback in a closed loop control system, the system sensitivity to parameter variations

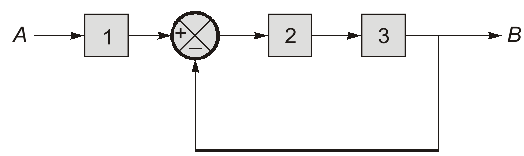
(a) increases (b) decreases

(c) becomes zero (d) becomes finite

Q.6 Original block diagram is given below.



Equivalent block diagram is given below.

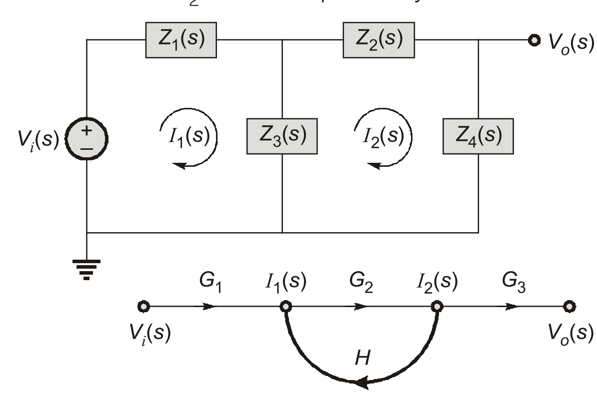


blocks 1, 2 and 3 are respectively

(a) G_1, G_2, G_1 (b) $\frac{1}{G_1}, \frac{1}{G_2}, \frac{1}{G_1}$

(c) $\frac{1}{G_2}, G_2, G_1$ (d) $\frac{1}{G_1}, G_1, G_2$

Q.7 An electrical system and its signal flow graph representation are shown in figure below. The value of G_2 and H respectively are



(a) $\dfrac{Z_3(s)}{Z_2(s)+Z_3(s)+Z_4(s)}, \dfrac{-Z_3(s)}{Z_1(s)+Z_3(s)}$

(b) $\dfrac{-Z_3(s)}{Z_2(s)-Z_3(s)+Z_4(s)}, \dfrac{-Z_3(s)}{Z_1(s)+Z_3(s)}$

(c) $\dfrac{-Z_3(s)}{Z_2(s)-Z_3(s)+Z_4(s)}, \dfrac{Z_3(s)}{Z_1(s)+Z_3(s)}$

(d) $\dfrac{Z_3(s)}{Z_2(s)+Z_3(s)+Z_4(s)}, \dfrac{Z_3(s)}{Z_1(s)+Z_3(s)}$

Q.8 The open loop DC gain of a unity negative feedback system with closed loop transfer function $\dfrac{s+4}{s^2+7s+13}$ is

UNIT 4

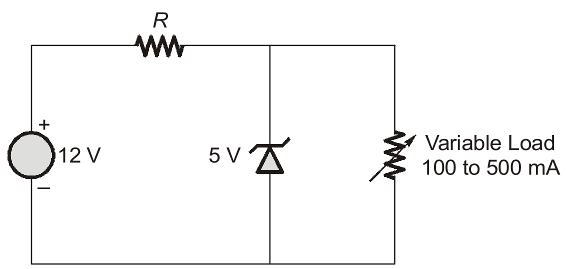
Analog Electronics

1. Diode Circuits

Q.1 A DC power supply has a no-load voltage of 30 V, and a full-load voltage of 25 V at a full-load current of 1 A. Its output resistance and load regulation, respectively, are

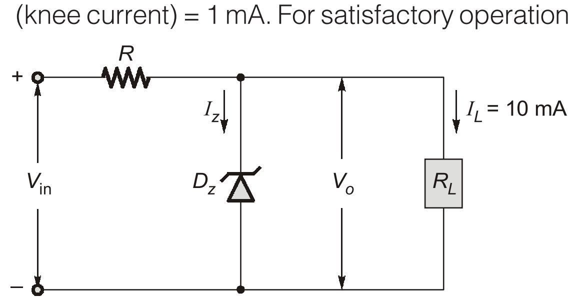
(a) 5 Ω and 20% (b) 25 Ω and 20%
(c) 5 Ω and 16.7% (d) 25 Ω and 16.7%

Q.2 In the voltage regulator shown in the figure below, the load current can vary from 100 mA to 500 mA. Assuming that the Zener diode is ideal (i.e., the Zener knee current is negligibly small and Zener resistance is zero in the breakdown region), the value of R is



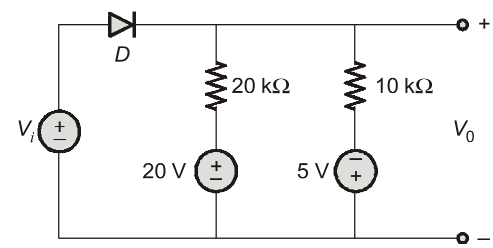
(a) 7 Ω (b) 70 Ω
(c) $\frac{70}{3}$ Ω (d) 14 Ω

Q.3 A Zener diode regulator in the figure is to be designed to meet the specifications: I_L = 10 mA, V_0 = 10 V and V_{in} varies from 30 V to 50 V. The Zener diode has V_z = 10 V and I_{zk} (knee current) = 1 mA. For satisfactory operation

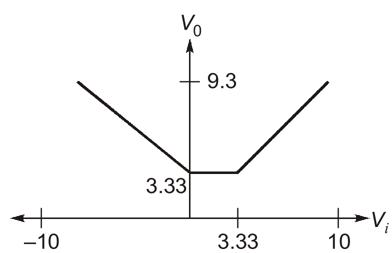


(a) $R \leq 1818$ Ω
(b) 2000 Ω $\leq R \leq$ 2200 Ω
(c) 3700 Ω $\leq R \leq$ 4000 Ω
(d) $R > 4000$ Ω

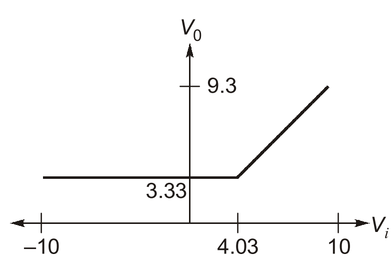
Q.4 For the circuit in the figure below, let cut-in voltage V_γ = 0.7 V.
The plot of V_0 verses V_i for $-10 \leq V_i \leq 10$ V is



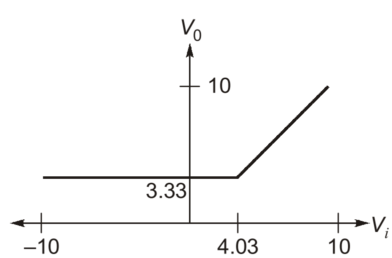
(a)



(b)



(c)



(d)