

GATE-2008

Question Paper

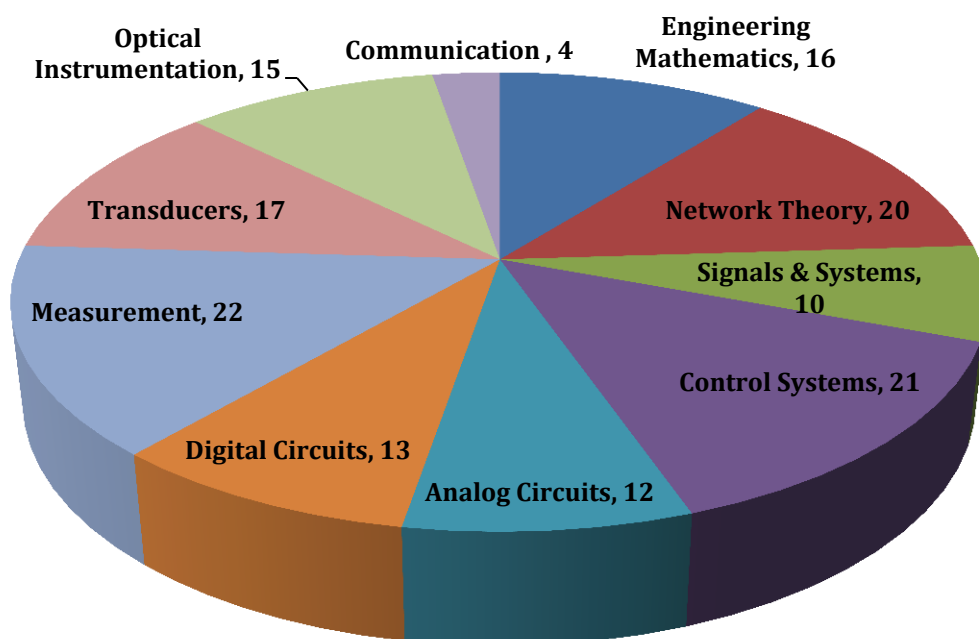
&

Answer Keys

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1. Question Paper Analysis
2. Question Paper & Answer keys

ANALYSIS OF GATE 2008 Instrumentation Engineering



GATE-2008- IN

SUBJECT	NO OF QUESTION	Topics Asked in Paper	Total Marks
Engineering Mathematics	1M:2 2M:7	Linear Algebra, Differential Equations, Probability and Distribution, Numerical Methods, Probability and Distribution, Complex Variables	16
Network Theory	1M:2 2M:9	Network Solution Methodology, Transient/Steady State Analysis of RLC Circuits, Sinusoidal Steady State Analysis	20
Signals & Systems	1M:2 2M:4	Introduction to Signals & Systems, Discrete Fourier Analysis, Fourier Representation of Signals, Z-Transform	10
Control Systems	1M:1 2M:10	Frequency Response Analysis Using Bode Plot, Time Domain Analysis, Root Locus Technique Time Domain Analysis, State Variable Analysis, Compensators & Controllers	21
Analog Circuits	1M:4 2M:4	AC & DC Biasing-BJT and FET, Diode Circuits- Analysis and Application, Operational Amplifiers & Its Applications, Feedback & Oscillator Circuits,	12
Digital Circuits	1M:1 2M:6	Introduction to Microprocessors, Number Systems & Code Conversions, Combinational & Sequential Digital Circuits, Introduction to Microprocessors, Boolean Algebra & Karnaugh Maps, Combinational & Sequential Digital Circuits	13
Measurement	1M:2 2M:10	Basics of Measurements and Error Analysis, Measurements of Basic Electrical Quantities 1, Measurements of Basic Electrical Quantities 2, Electronic Measuring Instruments 1, Electronic Measuring Instruments 2	22
Transducers	1M:3 2M:7	Piezo Electric Transducers, Classification of Transducers, Measurement of Non Electrical Quantities, Piezo Electric Transducers, Resistive Transducers	17
Optical Instrumentation	1M:3 2M:6	U.V, Visible and IR spectrometry, ECG EEG EMG, Basics of Fiber Optics, X ray and Nuclear Radiation Measurements, Ultrasonic Transducers and Ultrasonography, Interferometer, Applications in Meteorology, "Clinical Measurement and Computer Assisted Tomography, Optical Sources and Detectors	15
Communication	1M:0 2M:2	Amplitude Modulation (AM), DSBSC,SSB and VSB Modulation	4
Total	85		150

**GATE 2008 Examination
Instrumentation Engineering**

Q.1 - Q.20 Carry One Mark each.

1. Given $y = x^2 + 2x + 10$, the value of $\frac{dy}{dx}\bigg|_{x=1}$ is equal to

(A) 0 (C) 12
(B) 4 (D) 13

[Ans. C]

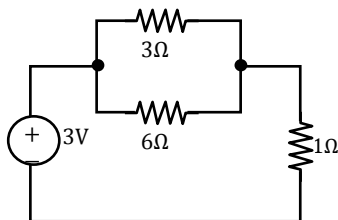
- 2.

$\lim_{X \rightarrow 0} \frac{\sin X}{X}$ is

(A) Indeterminate (C) 1
(B) 0 (D) ∞

[Ans. B]

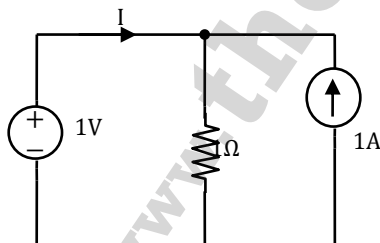
3. The power supplied by the dc voltage source in the circuit shown below is



(A) 0W (C) 2.5W
(B) 1.0W (D) 3.0W

[Ans. D]

4. The current I supplied by the dc voltage source in the circuit shown below is



(A) 0A (C) 1A
(B) 0.5A (D) 2A

[Ans. A]

5. For signal conditioning of a piezoelectric type transducer we require

(A) a charge amplifier
(B) a differential amplifier
(C) an instrumentation amplifier
(D) a transconductance amplifier

[Ans. A]

6. A linear variable differential transformer (LVDT) is
 (A) A displacement transducer
 (B) An impedance matching transformer
 (C) A differential temperature sensor
 (D) An auto transformer

[Ans. A]

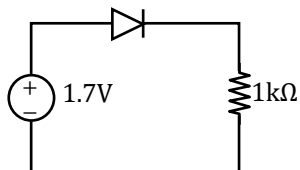
7. The temperature being sensed by a negative temperature coefficient (NTC) type thermistor is linearly increasing. Its resistance will
 (A) linearly increase with temperature
 (B) exponentially increase with temperature
 (C) linearly decrease with temperature
 (D) exponentially decrease with temperature

[Ans. D]

8. For a single stage BJT common base amplifier
 (A) current gain as well as voltage gain can be greater than unity
 (B) current gain can be greater than unity but voltage gain is always less than unity
 (C) voltage gain can be greater than unity but current gain is always less than unity
 (D) current gain as well as voltage gain is always less than unity

[Ans. C]

9. In the circuit shown below, the ideality factor η of the diode is unity and the voltage drop across it is 0.7V. The dynamic resistance of the diode at room temperature is approximately,



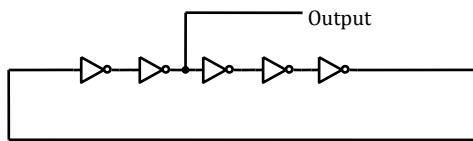
- (A) 15 Ω (C) 50 Ω
 (B) 25 Ω (D) 700 Ω

[Ans. B]

10. An ideal op-amp has the characteristics of an ideal
 (A) Voltage controlled voltage source
 (B) Voltage controlled current source
 (C) Current controlled voltage source
 (D) Current controlled current source

[Ans. A]

11. The inverters in the ring oscillator circuit shown below are identical. If the output waveform has a frequency of 10 MHz, the propagation delay of each inverter is



- (A) 5 ns (C) 20 ns
(B) 10 ns (D) 50 ns

[Ans. B]

12. A $2k \times 8$ bit RAM is interfaced to an 8-bit microprocessor. If the address of the first memory location in the RAM is 0800H, the address of the last memory location will be

- (A) 1000H (C) 4800H
(B) 0FFFH (D) 47FFH

[Ans. B]

13. The fundamental period of the discrete-time signal $x[n] = e^{j(\frac{5\pi}{6})n}$ is

- (A) $6/5\pi$ (C) 6
(B) $12/5$ (D) 12

[Ans. D]

14. Which one of the following discrete-time systems is time invariant?

- (A) $y[n] = nx[n]$ (C) $y[n] = x[-n]$
(B) $y[n] = x[3n]$ (D) $y[n] = x[n-3]$

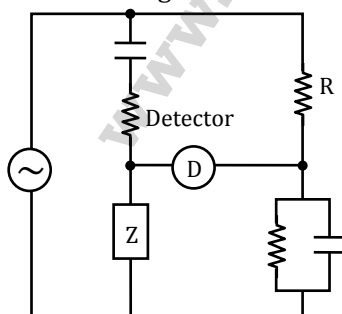
[Ans. D]

15. If a current of $[-6\sqrt{2} \sin(100\pi t) + 6\sqrt{2} \cos(300\pi t + \pi/4) + 6\sqrt{2}]$ A is passed through a true RMS ammeter, the meter reading will be

- (A) $6\sqrt{2}$ A (C) 12 A
(B) $\sqrt{126}$ A (D) $\sqrt{216}$ A

[Ans. C]

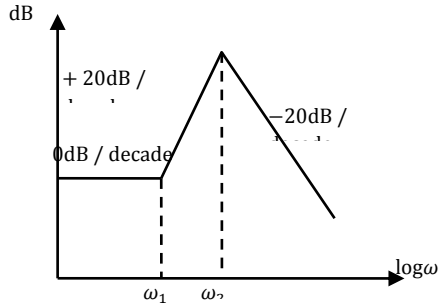
16. If the ac bridge circuit shown below is balanced the elements Z can be a



- (A) Pure capacitor (C) R-L series combination
(B) Pure inductor (D) R-L parallel combination

[Ans. A]

17. The Bode asymptotic plot of a transfer function is given below. In the frequency range shown, the transfer function has



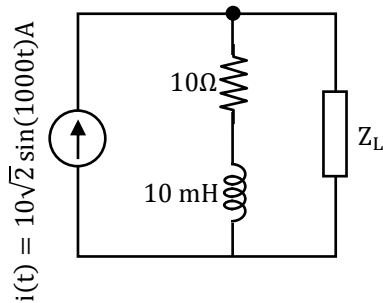
- (A) 3 poles and 1 zero
(B) 1 pole and 2 zeroes
(C) 2 poles and 1 zero
(D) 2 poles and 2 zeroes
[Ans. C]
18. For radioisotope imaging, an Anger camera is fitted with a parallel hole collimator. If the thickness of the collimator is increased, the camera
(A) resolution and sensitivity will increase
(B) resolution and sensitivity will decrease
(C) resolution will increase and sensitivity will decrease
(D) resolution will decrease and sensitivity will increase
[Ans. C]
19. In the standard 12-lead ECG recording system, the minimum number of electrodes required to be attached to a human subject for recording any one of the unipolar chest lead signals is
(A) 1
(B) 2
(C) 4
(D) 5
[Ans. D]
20. A laser light with a wavelength of 633 nm is passed through 1cm length of tissue and 2cm length of glass. The refractive indices of tissue and glass are 1.33 and 1.5 respectively. The velocities of laser light in the tissue and in the glass are in the ratio of
(A) 1.33 : 0.75
(B) 1.33 : 3.0
(C) 1.33 : 1.5
(D) 1.5 : 1.33
[Ans. D]

Q.21 - Q.75 Carry Two Mark each.

21. The expression $e^{-\ln x}$ for $x > 0$ is equal to
(A) $-x$
(B) x
(C) x^{-1}
(D) $-x^{-1}$
[Ans. C]

22. Consider the differential equation $\frac{dy}{dx} = 1 + y^2$. Which one of the following can be a particular solution of this differential equation?
- (A) $y = \tan(x + 3)$ (C) $x = \tan(y + 3)$
 (B) $y = \tan x + 3$ (D) $x = \tan y + 3$
[Ans. A]
23. Consider the function $y = x^2 - 6x + 9$. The maximum value of y obtained when x varies over the interval 2 to 5 is
- (A) 1 (C) 4
 (B) 3 (D) 9
[Ans. C]
24. It is known that two roots of the nonlinear equation $x^3 - 6x^2 + 11x - 6 = 0$ are 1 and 3. The third root will be
- (A) j (C) 2
 (B) $-j$ (D) 4
[Ans. C]
25. Consider a Gaussian distributed random variable with zero mean and standard deviation σ . The value of its cumulative distribution function at the origin will be
- (A) 0 (C) 1
 (B) 0.5 (D) 10σ
[Ans. D]
26. A random variable is uniformly distributed over the interval 2 to 10. Its variance will be
- (A) $16/3$ (C) $256/9$
 (B) 6 (D) 36
[Ans. D]
27. The fourier transform $x(t) = e^{-at}u(-t)$, when $u(t)$ is unit step function,
- (A) Exist for any real value of a
 (B) Does not exist for any real value of a
 (C) Exists if any real value of a is strictly negative
 (D) Exists if the real value of a is strictly positive
[Ans. C]

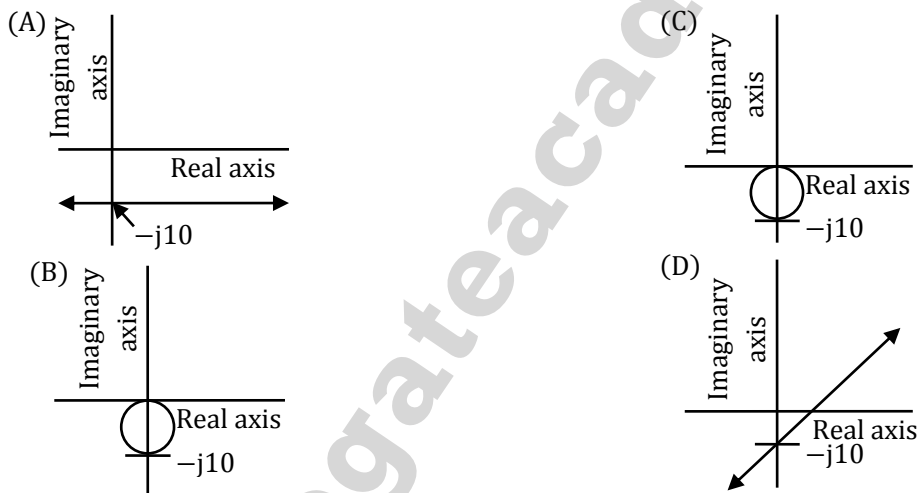
28. In the circuit shown below the maximum power that can be transferred to the load Z_L is



- (A) 250 W (C) 1000 W
(B) 500 W (D) 2000 W

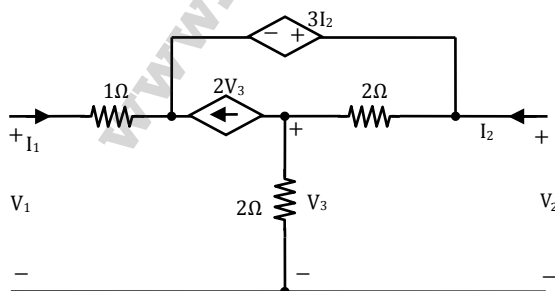
[Ans. B]

29. A complex variable $Z = x + j0.1$ has its real part x varying in the range $-\infty$ to $+\infty$. Which one of the following is the locus (shown in thick lines) of $1/Z$ in the complex plane?



[Ans. B]

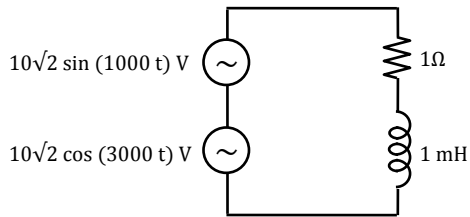
30. For the circuit shown below the input resistance $R_{11} = \frac{V_1}{I_1} \Big|_{I_2=0}$ is



- (A) -3Ω (C) 3Ω
(B) 2Ω (D) 13Ω

[Ans. D]

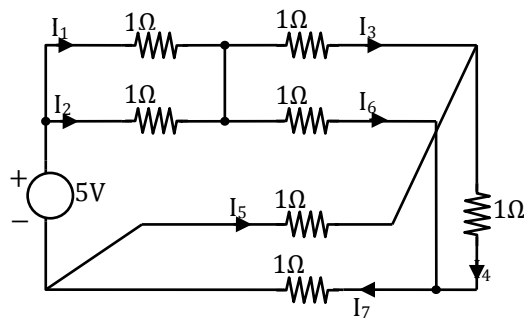
31. In the circuit below the average power consumed by the 1Ω resistor is



- (A) 50 W (C) 5000 W
(B) 1050 W (D) 10100 W

[Ans. D]

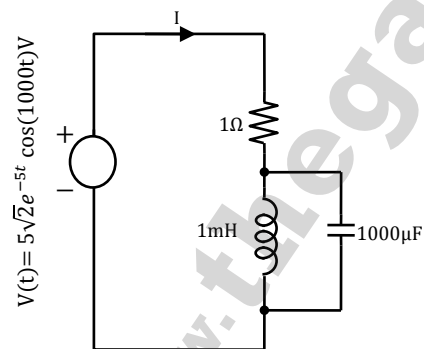
32. Which one of the following equations is valid for the circuit shown below?



- (A) $I_3 + I_5 - I_6 + I_7 = 0$ (C) $I_3 + I_5 + I_6 + I_7 = 0$
(B) $I_3 - I_5 + I_6 + I_7 = 0$ (D) $I_3 + I_5 + I_6 - I_7 = 0$

[Ans. D]

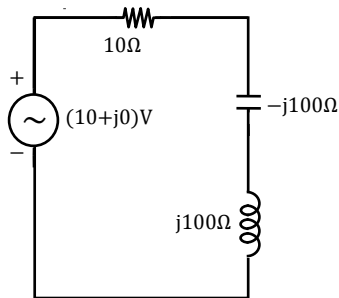
33. For the circuit shown below the steady-state current I is



- (A) 0A (C) $5\sqrt{2} \cos\left(1000t - \frac{\pi}{4}\right) A$
(B) $5\sqrt{2} \cos(1000t) A$ (D) $5\sqrt{2} A$

[Ans. A]

34. For the circuit shown below the voltage across the capacitor is



- (A) $(10 + j 0)V$ (C) $(0 + j100)V$
 (B) $(100 + j0)V$ (D) $(0 - j100)V$
[Ans. D]

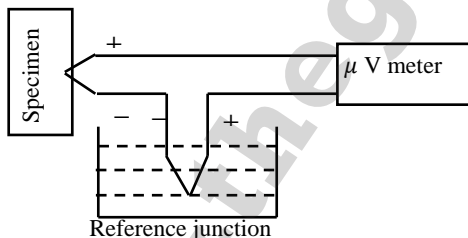
35. The speed of a gear having 60 teeth is measured using a proximity sensor. The output of the proximity sensor is fed to a counter with a gating time of 1s. The counter indicates a value of 120. The speed at which the gear is rotating is

- (A) 60 rpm (C) 600 rpm
 (B) 120 rpm (D) 1200 rpm
[Ans. B]

36. A piezoelectric type accelerometer has a sensitivity of 100mV/g. The transducer is subjected to a constant acceleration of 5g. The steady state output of the transducer will be

- (A) 0V (C) 0.5V
 (B) 100mV (D) 5V
[Ans. C]

37. A pair of identical thermocouples is employed for measuring the temperature of a specimen as shown below. The characteristic of the thermocouples is tabulated below. The reference junction is at 2°C. The meter reads 48μV. The correct temperature of the specimen is



Temperature(°C)	0	10	20	30	40	50	60	70	80	90
Output(μV)	35	45	55	65	75	85	95	105	115	125

- (A) 13°C (C) 48°C
 (B) 46°C (D) 50°C
[Ans. D]

38. A strain gauge has a nominal resistance of 600Ω and a gauge factor of 2.5. The strain gauge is connected in a dc bridge with three other resistance of 600 Ω each. The bridge is excited by a 4V battery. If the strain gauge is subjected to a strain of 100μm/m, the magnitude of bridge output will be

- (A) 0V (C) 500 μV
 (B) 250 μV (D) 750 μV
[Ans. B]

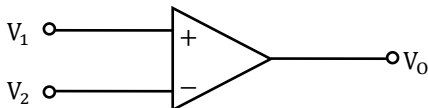
39. The torque in a rotating shaft is measured using strain gauges. The strain gauges must be positioned on the shaft such that the axes of the strain gauges are at
- (A) 0° with respect to the axis of the shaft
 - (B) 30° with respect to the axis of the shaft
 - (C) 45° with respect to the axis of the shaft
 - (D) 90° with respect to the axis of the shaft

[Ans. C]

40. To reduce the effect of fringing in a capacitive type transducer
- (A) the transducer is shielded and the shield is kept at ground potential
 - (B) a guard ring is provided and it is kept at ground potential
 - (C) the transducer is shielded and the shield is kept at the same potential as the moving plate
 - (D) a guard ring is provided and it is kept at the same potential as the moving plate

[Ans. B]

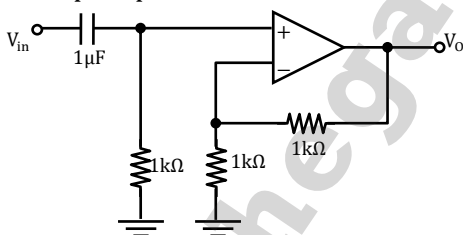
41. A differential amplifier shown below has a differential mode gain of 100 and a CMRR of 40dB. If $V_1 = 0.55V$ and $V_2 = 0.45V$, the output V_0 is



- (A) 10V
- (B) 10.5V
- (C) 11V
- (D) 15V

[Ans. B]

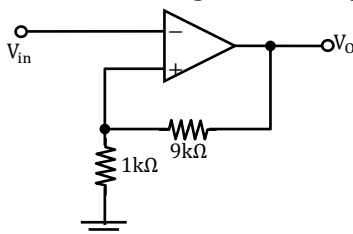
42. The op-amp circuit shown below is that of a



- (A) Low-pass filter with a max. gain of 1
- (B) Low-pass filter with a max. gain of 2
- (C) High-pass filter with a max. gain of 1
- (D) High-pass filter with a max. gain of 2

[Ans. D]

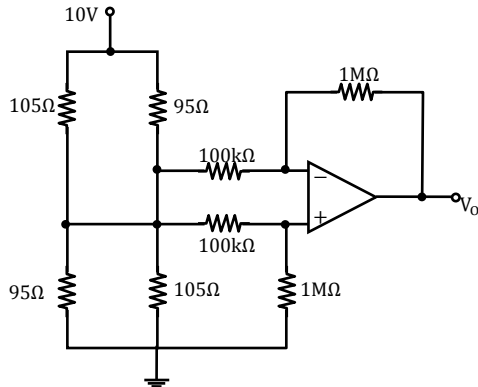
43. In the op-amp circuit shown below the input voltage v_{in} is gradually increased from $-10V$ to $+10V$. Assuming that the output voltage v_{out} saturates at $-10V$ and $+10V$, v_{out} will change from



- (A) $-10V$ to $+10V$ when $v_{in} = -1V$
- (B) $-10V$ to $+10V$ when $v_{in} = +1V$
- (C) $+10V$ to $-10V$ when $v_{in} = -1V$
- (D) $+10V$ to $-10V$ when $v_{in} = +1V$

[Ans. D]

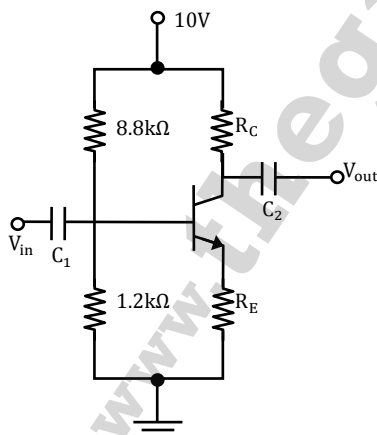
44. For the op-amp circuit shown below V_o is approximately equal to



- (A) $-10V$
- (B) $-5V$
- (C) $+5V$
- (D) $+10V$

[Ans. B]

45. In the amplifier circuit shown below, assume $V_{BE} = 0.7V$ and the β of the transistor and the values of C_1 and C_2 are extremely high. If the amplifier is designed such that at the quiescent point its $V_{CE} = \frac{V_{CC}}{2}$ where V_{CC} is the power supply voltage, its small signal voltage gain $\left| \frac{V_{out}}{V_{in}} \right|$ will be



- (A) 3.75
- (B) 4.5
- (C) 9
- (D) 19

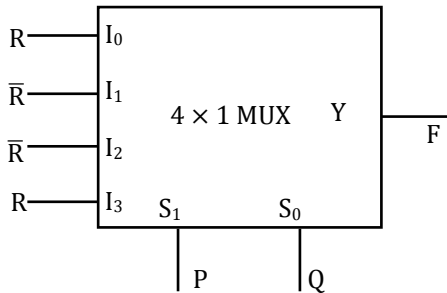
[Ans. A]

46. The result of $(45)_{10} - (45)_{16}$ expressed in 6-bit 2's complement representation is,

- (A) 011000
- (B) 100111
- (C) 101000
- (D) 101001

[Ans. C]

47. The output F of the multiplexer circuit shown below expressed in terms of the inputs P, Q and R is



- (A) $F = P \oplus Q \oplus R$ (C) $F = (P \oplus Q) R$
 (B) $F = PQ + QR + RP$ (D) $F = (P \oplus Q)\bar{R}$
[Ans. A]

48. A part of a program written for an 8085 microprocessor is shown below. When the program execution reaches LOOP2, the value of register C will be

```
SUB A
MOV C, A
LOOP1: INR A
DAA
JC LOOP2
JNC LOOP1
LOOP2: NOP
```

- (A) 63H (C) 99H
 (B) 64H (D) 100H
[Ans. A]

49. The minimum sum of products form of the Boolean expression

$$Y = P\bar{Q}RS + P\bar{Q}\bar{R}S + P\bar{Q}RS + P\bar{Q}RS + P\bar{Q}RS + P\bar{Q}RS$$

- (A) $Y = P\bar{Q} + \bar{Q}\bar{S}$ (C) $Y = P\bar{Q} + \bar{Q}\bar{R}S$
 (B) $Y = P\bar{Q} + \bar{Q}\bar{R}S$ (D) $Y = \bar{Q}\bar{S} + P\bar{Q}R$
[Ans. A]

50. An X-ray tube is operated at 80kV anode voltage. In order to filter the low intensity X-rays, a 2.5mm thick aluminum filter is used. It is given that at 80 kV anode voltage, the mass attenuation coefficients and densities of aluminum are $0.02 \text{ m}^2\text{Kg}^{-1}$ and 2699Kg m^{-3} respectively and for copper these are $0.075\text{m}^2\text{Kg}^{-1}$ and 8960 Kg m^{-3} respectively. If a copper filter is to replace the aluminum filter with the same filtering effect, the thickness of the copper filter should be

- (A) 0.2mm (C) 1.5mm
 (B) 0.66mm (D) 5mm
[Ans. A]

51. A 5 MHz acoustic pulse travels from a transducer through a 2cm thick fat tissue before it encounters an interface with a liver tissue at normal incidence. The amplitude attenuation factors of fat and liver are $0.075\text{Npcm}^{-1}/\text{MHz}$ and $0.1\text{Npcm}^{-1} / \text{MHz}$ respectively. The amplitude reflectivity coefficient of fat-liver interface is 0.1. Taking both attenuation and reflection losses into account, the amplitude loss (in dB) of echo pulse when it returns to the transducers is
- (A) 0.74 (C) -6
(B) -2.6 (D) -33
[Ans. D]
52. Consider a discrete-time LTI system with input $x[n] = \delta[n] + \delta[n-1]$ and impulse response $h[n] = \delta[n] - \delta[n-1]$. The output of the system will be given by
- (A) $\delta[n] - \delta[n-2]$ (C) $\delta[n-1] + \delta[n-2]$
(B) $\delta[n] - \delta[n-1]$ (D) $\delta[n] + \delta[n-1] + \delta[n-2]$
[Ans. A]
53. Consider a discrete-time system for which the input $x[n]$ and the output $y[n]$ are related as $y[n] = x[n] - \frac{1}{3}y[n-1]$. If $y[n] = 0$ for $n < 0$ and $x[n] = \delta[n]$, then $y[n]$ can be expressed in terms of the unit step $u[n]$ as
- (A) $\left(\frac{-1}{3}\right)^n u[n]$ (C) $(3)^n u[n]$
(B) $\left(\frac{1}{3}\right)^n u[n]$ (D) $(-3)^n u[n]$
[Ans. A]
54. If the bandwidth of a low-pass signal $g(t)$ is 3 kHz, the bandwidth of $g^2(t)$ will be
- (A) 3/2 kHz (C) 6 kHz
(B) 3 kHz (D) 9 kHz
[Ans. *]
55. Consider the AM signal $s(t) = [1 + m(t)] \cos 2\pi f_c t$. It is given that the bandwidth of the real, low - pass message signal $m(t)$ is 2 kHz. If $f_c = 2\text{MHz}$, the bandwidth of the band- pass signal $s(t)$ will be
- (A) 2.004 MHz (C) 4 kHz
(B) 2 MHz (D) 2 kHz
[Ans. C]
56. Ten real, band pass message signals each of bandwidth 3 kHz, are to be frequency division multiplexed on a band pass channel with bandwidth B kHz. If the guard band is between any two adjacent signals should be of 500 Hz width and there is no need to provide any guard band at the edge of the band pass channel the value of B should be at least
- (A) 30 (C) 35
(B) 34.5 (D) 35.5
[Ans. B]

57. The region of convergence of the z-transform of the discrete-time signal $x[n] = 2^n u[n]$ will be

- (A) $|Z| > 2$ (C) $|Z| > \frac{1}{2}$
(B) $|Z| < 2$ (D) $|Z| < \frac{1}{2}$

[Ans. A]

58. The step response of a linear time invariant system is $y(t) = 5 e^{-10t} u(t)$, where $u(t)$ is the unit step function. If the output of system corresponding to an impulse input $\delta(t)$ is $h(t)$, then $h(t)$ is

- (A) $-50 e^{-10t} u(t)$ (C) $5 u(t) - 50 e^{-10t} u(t)$
(B) $5 e^{-10t} \delta(t)$ (D) $5 \delta(t) - 50 e^{-10t} u(t)$

[Ans. D]

59. A 2A full-scale PMMC type dc ammeter has a voltage drop of 100 mV at 2A. The meter can be converted into a 10A full-scale dc ammeter by connecting a

- (A) 12.5 m Ω resistor in parallel with the meter
(B) 12.5 m Ω resistor in series with the meter
(C) 50.0 m Ω resistor in parallel with the meter
(D) 50.0 m Ω resistor in series with the meter

[Ans. A]

60. A $3\frac{1}{2}$ digit, 200 mV full scale DVM has an accuracy specification of $\pm 0.5\%$ of reading plus 5 counts. When the meter reads 100 mV, the voltage being measured as

- (A) Any value between 99.5 mV and 100.5 mV
(B) Any value between 99.0 mV and 101.0 mV
(C) Exactly 99.5 mV
(D) Exactly 100 mV

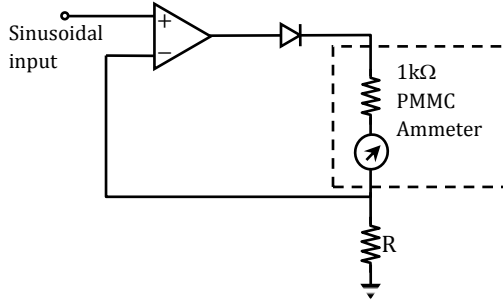
[Ans. B]

61. A 230 V, 5A, 50 Hz single phase house service energy meter has a meter constant of 360 rev/KWhr. The meter takes 50s for making 51 revolutions of the disc when connected to a 10 kW, unity power factor load. The error in the reading of the meter is

- (A) 0% (C) -2.0%
(B) +0.5% (D) +2.0%

[Ans. D]

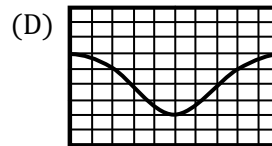
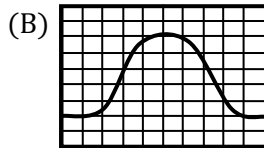
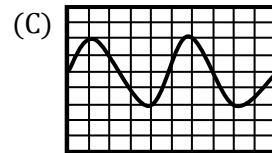
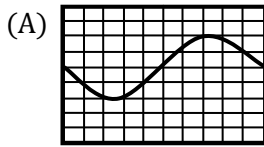
62. The op-amp based circuit of a half wave rectifier electronic voltmeter shown below uses a PMMC ammeter with a full scale deflection (FSD) current of 1 mA and a coil resistance of 1k Ω . The value of R that gives FSD for a sinusoidal input voltage of 100 mV (RMS) is



- (A) 45 Ω (C) 100 Ω
(B) 67.5 Ω (D) 144.4 Ω

[Ans. A]

63. The x and y sensitivities of an analog oscilloscope are set as 2 ms/cm and 1V/cm respectively. The trigger is set at 0V with negative slope. An input of $2 \cos(100\pi t + 30^\circ)$ V is fed to the y input of the oscilloscope. The waveform seen on the oscilloscope will be



[Ans. A]

64. The open loop transfer function of a unity feedback system is

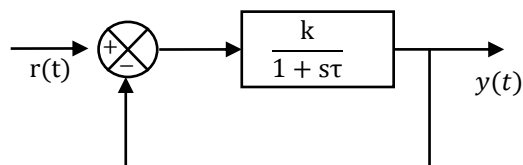
$$G(s) = \frac{K(s + 2)}{(s + 1 + j1)(s + 1 - j1)}$$

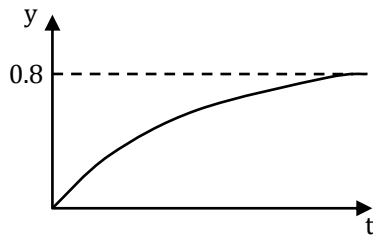
The root locus plot of the system has

- (A) Two breakaway points located at $s = -0.59$ and $s = -3.41$
(B) One breakaway point located at $s = -0.59$
(C) One breakaway point located at $s = -3.41$
(D) One breakaway point located at $s = -1.41$

[Ans. C]

65. If a first order system and its time response to a unit step input are as shown below, the gain K is





- (A) 0.25 (C) 1
(B) 0.8 (D) 4

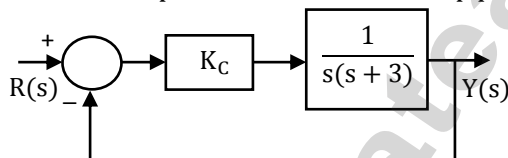
[Ans. D]

66. The state space representation of a system is given by $\dot{X} = \begin{bmatrix} 0 & 1 \\ 0 & -3 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$, $y = [1 \ 0]x$. The transfer function $\frac{Y(s)}{U(s)}$ of the system will be

- (A) $\frac{1}{s}$ (C) $\frac{1}{s+3}$
(B) $\frac{1}{s(s+3)}$ (D) $\frac{1}{s^2}$

[Ans. A]

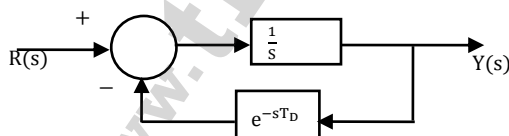
67. A closed loop control system is shown below. The range of the controller gain K_C which will make the real parts of all the closed loop poles more negative than -1 is



- (A) $K_C > -4$ (C) $K_C > 2$
(B) $K_C > 0$ (D) $K_C < 2$

[Ans. C]

68. For the closed loop system shown below to be stable, the value of time delay T_D (in seconds) should be less than



- (A) $\pi/4$ (C) $\pi/2$
(B) $\pi/3$ (D) π

[Ans. C]

69. A tissue with a refractive index 1.33 is introduced in one of the light paths of a Michelson interferometer operating with a monochromatic coherent light source of wavelength 589nm. After the introduction of a tissue sample of thickness Δt , the fringe pattern is observed to shift by 50 fringes. If the thickness is $2\Delta t$, the fringe pattern will shift by

- (A) 25 fringes (C) 100 fringes
(B) 50 fringes (D) 200 fringes

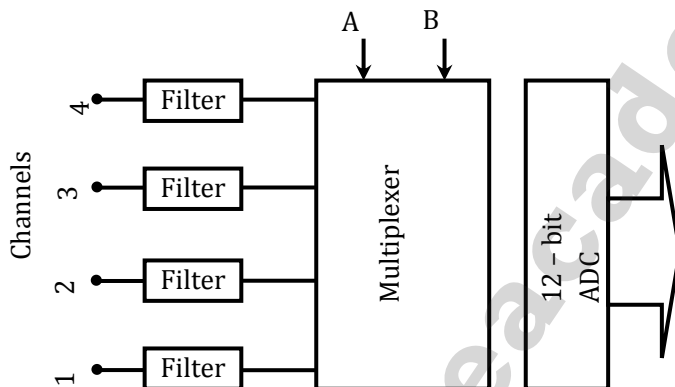
[Ans. C]

70. In the process of non-destructive testing of a 10 cm diameter cylinder, a cross-sectional (transaxial) image of the cylinder is reconstructed with the help of parallel beam computer tomography technique. To realize the spatial resolution of 1 mm in the image, the minimum number of ray samples in each projection set and the minimum set and the minimum number of projection sets required are
- (A) 200 and 315 respectively (C) 200 and 629 respectively
(B) 100 and 315 respectively (D) 100 and 629 respectively
- [Ans. *]

Common Data Questions

Common Data Questions 71, 72 & 73:

A data acquisition system (DAS) shown below employs a successive approximation type 12-bit ADC having a conversion time of 5 μ s.



71. The quantization error of the ADC is
- (A) 0% (C) $\pm 0.024\%$
(B) $\pm 0.012\%$ (D) $\pm 0.048\%$
- [Ans. *]
72. The system is used as a single channel DAS with channel 1 selected as input to the ADC which is set in the continuous conversion mode. For avoiding aliasing error, the cutoff frequency f_c of the filter in channel 1 should be
- (A) $f_c < 100\text{kHz}$ (C) $100\text{kHz} < f_c < 200\text{kHz}$
(B) $f_c = 100\text{kHz}$ (D) $f_c = 200\text{kHz}$
- [Ans. *]
73. If the multiplexer is controlled such that the channels are sequenced every 5 μ s as 1, 2, 1, 3, 1, 4, 1, 2, 1, 3, 1, 4, 1....., the input connected to channel 1 will be sampled at the rate of
- (A) 25k samples/s (C) 100k samples/s
(B) 50k samples/s (D) 200k samples/s
- [Ans. *]

Common Data Questions 74 & 75

Laser light is generated by energizing helium-neon gas in a chamber. The ground and metastable states of helium are 0eV and 20.61eV respectively. The ground, higher and metastable energies of neon are 0eV, 18.70eV and 20.66eV respectively. The values of speed of light, Planck constant and charge of electron are $3 \times 10^8\text{m/s}$, $6.625 \times 10^{-34}\text{Js}$ and

- 1.6×10^{-19} C respectively
74. In this process, helium molecules
- (A) play no role
 - (B) produce laser light
 - (C) give energy to neon molecules
 - (D) absorb energy from neon molecules

[Ans. C]

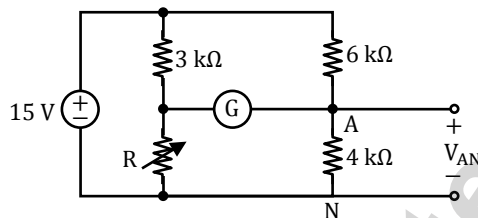
75. Wavelength of laser light generated in this process is
- (A) 61.6 nm
 - (B) 66.4 nm
 - (C) 633.8 nm
 - (D) 650.3 nm

[Ans. C]

Linked Answer Questions: Q.76 to Q.85 carry two marks each

Statement for Linked Answer Questions 76 and 77

In the wheatstone bridge shown below the galvanometer G has a current sensitivity of $1\mu\text{A}/\text{mm}$, a resistance of $2.5\text{ k}\Omega$ and a scale resolution of 1 mm. let ΔR be the minimum increase in R from its nominal value of $2\text{ k}\Omega$ that can be detected by this bridge.



76. When R is $2\text{ k}\Omega + \Delta R$, V_{AN} is
- (A) 6 V
 - (B) 6.0024 V
 - (C) 6.0038 V
 - (D) 6.005 V

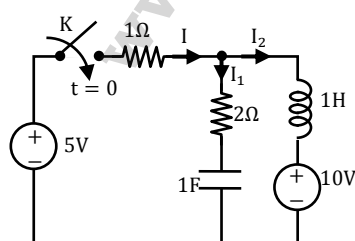
[Ans. B]

77. The value of ΔR is approximately
- (A) $2.8\ \Omega$
 - (B) $3.4\ \Omega$
 - (C) $5.2\ \Omega$
 - (D) $12\ \Omega$

[Ans. B]

Statement for Linked Answer Q.No. 78 & 79

In the circuit shown below the steady-state is reached with the switch K open subsequently the switch is closed at time $t=0$.



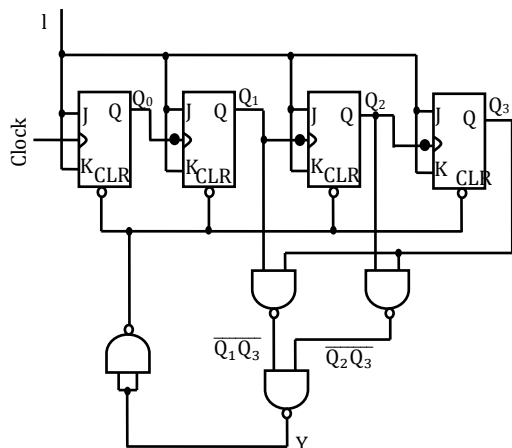
78. At time $t=0^+$, current I is
- (A) $-(5/3)\text{ A}$
 - (B) 0 A
 - (C) $5/3\text{ A}$
 - (D) $\infty\text{ A}$

[Ans. A]

79. At time $t = 0^+$, is $\frac{dI_2}{dt}$ is
- (A) $-5A/s$ (C) $0A/s$
 (B) $-(10/3)A/s$ (D) $5A/s$
[Ans. B]

Statement for Linked Answer Questions 80 and 81

Consider the counter circuit shown below.



80. In the above figure, Y can be expressed as
- (A) $Q_3(Q_2 + Q_1)$ (C) $\overline{Q_3(Q_2 + Q_1)}$
 (B) $Q_3 + Q_2Q_1$ (D) $\overline{Q_3 + Q_2Q_1}$
[Ans. A]
81. The above circuit is a
- (A) Mod - 8 Counter (C) Mod - 10 Counter
 (B) Mod - 9 Counter (D) Mod - 11 Counter
[Ans. C]

Statement for Linked Answer Q. No. 82 & 83

Consider a unity feedback system with open loop transfer function

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

82. The phase crossover frequency of the system in radians per second is
- (A) 0.125 (C) 0.5
 (B) 0.25 (D) 1
[Ans. C]
83. The gain margin of the system is
- (A) 0.125 (C) 0.5
 (B) 0.25 (D) 1
[Ans. A]

Statement for Linked Answer Q.No.84 & 85

A unity feedback system has open loop transfer function $G(s) = \frac{100}{s(s+p)}$. The time at which the response to a unit step input reaches its peak is $\frac{\pi}{8}$ seconds

84. The damping coefficient for the closed loop system is
- | | |
|---------|---------|
| (A) 0.4 | (C) 0.8 |
| (B) 0.6 | (D) 1 |

[Ans. B]

85. The value of p is
- | | |
|--------|--------|
| (A) 6 | (C) 14 |
| (B) 12 | (D) 16 |

[Ans. B]

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