GENERAL APTITUDE

Q. No. 1 – 5 Carry One Mark Each

1. Statement: You can always give me a ring whenever you need.

Which one of the following is the best inference from the above statement?

(A) Because I have a nice caller tune

(B) Because I have a better telephone facility

(C) Because a friend in need in a friend indeed

(D) Because you need not pay towards the telephone bills when you give me a ring

Answer: (C)

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2. Complete the sentence:

Dare ____________ mistakes.

(A) commit (B) to commit (C) committed (D) committing

Answer: (B)

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3. Choose the grammatically CORRECT sentence:

(A) Two and two add four (B) Two and two become four

(C) Two and two are four (D) Two and two make four

Answer: (D)

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4. They were requested not to quarrel with others.

Which one of the following options is the closest in meaning to the word quarrel?

(A) make out (B) call out (C) dig out (D) fall out

Answer: (D)

5. In the summer of 2012, in New Delhi, the mean temperature of Monday to Wednesday was 41ºC and of Tuesday to Thursday was 43ºC. If the temperature on Thursday was 15% higher than that of Monday, then the temperature in ºC on Thursday was

(A) 40 (B) 43 (C) 46 (D) 49

Answer: (C)

Q. No. 6 – 10 Carry Two Marks Each

6. Find the sum to n terms of the series 10 + 84 + 734 + …

(A) $\frac{9(9^n+1)}{10}+1$ (B) $\frac{9(9^n-1)}{8}+1$ (C) $\frac{9(9^n-1)}{8}+n$ (D) $\frac{9(9^n-1)}{8}+n^2$

Answer: (D)

7. The set of values of p for which the roots of the equation $3x^2+2x+p(p-1)=0$ are of opposite sign is

(A) $(-\infty,0)$ (B) $(0,1)$ (C) $(1,\infty)$ (D) $(0,\infty)$

Answer: (B)

8. A car travels 8 km in the first quarter of an hour, 6 km in the second quarter and 16km in the third quarter. The average speed of the car in km per hour over the entire journey is

(A) 30 (B) 36 (C) 40 (D) 24

Answer: (C)

9. What is the chance that a leap year, selected at random, will contain 53 Sundays?

(A) 2/7 (B) 3/7 (C) 1/7 (D) 5/7

Answer: (A)

10. Statement: There were different streams of freedom movements in colonial India carried out by the moderates, liberals, radicals, socialists, and so on.

Which one of the following is the best inference from the above statement?

(A) The emergence of nationalism in colonial India led to our Independence

(B) Nationalism in India emerged in the context of colonialism

(C) Nationalism in India is homogeneous

(D) Nationalism in India is heterogeneous

Answer: (D)

INSTRUMENTATION ENGINEERING

Q. No. 1 – 25 Carry One Mark Each

1. The dimension of the null space of the matrix $\begin{bmatrix} 0 & 1 & 1 \\ 1 & -1 & 0 \\ -1 & 0 & -1 \end{bmatrix}$ is

(A) 0 (B) 1 (C) 2 (D) 3

Answer: (B)

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2. If the A- matrix of the state space model of a SISO linear time invariant system is rank deficient, the transfer function of the system must have

(A) a pole with positive real part (B) a pole with negative real part

(C) a pole with positive imaginary part (D) a pole at the origin

Answer: (D)

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3. Two systems with impulse responses $h_1(t)$ and $h_2(t)$ are connected in cascade. Then the overall impulse response of the cascaded system is given by

(A) a product of $h_1(t)$ and $h_2(t)$ (B) sum of $h_1(t)$ and $h_2(t)$

(C) convolution of $h_1(t)$ and $h_2(t)$ (D) subtraction of $h_2(t)$ from $h_1(t)$

Answer: (C)

4. The complex function tanh (s) is analytic over a region of the imaginary axis of the complex s-plane if the following is TRUE everywhere in the region for all integers n

(A) $\mathrm{Re}(s) = 0$ (B) $\mathrm{Im}(s) \neq n\pi$

(C) $\mathrm{Im}(s) \neq \frac{n\pi}{3}$ (D) $\mathrm{Im}(s) \neq \frac{(2n+1)\pi}{2}$

Answer: (D)

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5. For a vector E, which one of the following statements is NOT TRUE?

(A) If $\nabla \cdot E = 0$, E is called solenoidal

(B) If $\nabla \times E = 0$, E is called conservative

(C) If $\nabla \times E = 0$, E is called irrotational

(D) If $\nabla \cdot E = 0$, E is called irrotational

Answer: (D)

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6. For a periodic signal $v(t) = 30\sin 100t + 10\cos 300t + 6\sin\left(500t + \frac{\pi}{4}\right)$, the fundamental frequency in rad/s is

(A) 100 (B) 300 (C) 500 (D) 1500

Answer: (A)

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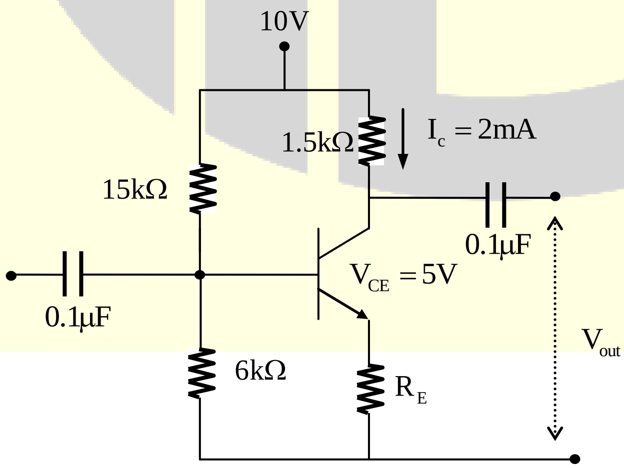
7. In the transistor circuit as shown below, the value of resistance R_E in $k\Omega$ is approximately,



(A) 1.0 (B) 1.5 (C) 2.0 (D) 2.5

Answer (A)

8. A source $V_s(t) = V\cos 100\pi t$ has an internal impedance of $4 + j3\Omega$. If a purely resistive load connected to this source has to extract the maximum power out of the source, its value in Ω should be

(A) 3 (B) 4 (C) 5 (D) 7

Answer: (C)

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9. Which of the following statements is NOT TRUE for a continuous time causal and stable LTI system?

(A) All the poles of the system must lie on the left side of the $j\omega$-axis

(B) Zeroes of the system can lie anywhere in the s-plane

(C) All the poles must lie within $|s| = 1$

(D) All the roots of the characteristic equation must be located on the left side of the $j\omega$-axis.

Answer: (C)

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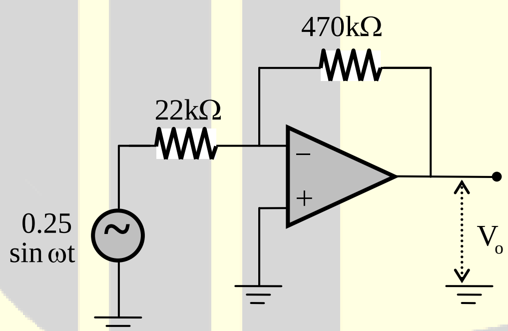
10. The operational amplifier shown in the circuit below has a slew rate of $0.8V/\mu s$. The input signal is $0.25\sin\omega t$.

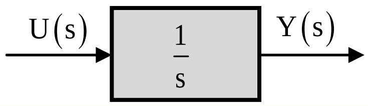


The maximum frequency of input in kHz for which there is no distortion in the output is

(A) 23.84 (B) 25.0 (C) 50.0 (D) 46.60

Answer: (A)

11. Assuming zero initial condition, the response y(t) of the system given below to a unit step input u(t) is



(A) $u(t)$ (B) $t\,u(t)$ (C) $\frac{t^2}{2}u(t)$ (D) $e^{-t}u(t)$

Answer: (B)

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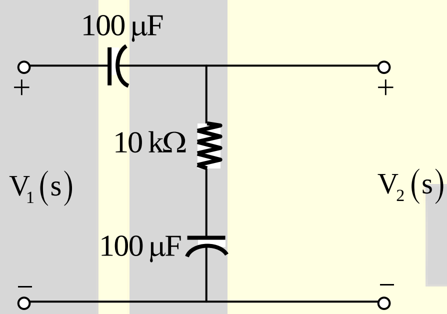
12. The transfer function $\frac{V_2(s)}{V_1(s)}$ of the circuit shown below is



(A) $\frac{0.5s+1}{s+1}$ (B) $\frac{3s+6}{s+2}$ (C) $\frac{s+2}{s+1}$ (D) $\frac{s+1}{s+2}$

Answer: (D)

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13. The type of partial differential equation $\frac{\partial f}{\partial t}=\frac{\partial^2 f}{\partial x^2}$ is

(A) Parabolic (B) Elliptic (C) Hyperbolic (D) Nonlinear

Answer: (A)

14. The discrete-time transfer function $\frac{1-2z^{-1}}{1-0.5z^{-1}}$ is

(A) Non-minimum phase and unstable (B) Minimum phase and unstable

(C) Minimum phase and stable (D) Non-minimum phase and stable

Answer: (D)

15. Match the following biomedical instrumentation techniques with their application.

P.	Otoscopy	U.	Respiratory volume measurement
Q.	Ultrasound Technique	V.	Ear diagnostics
R.	Spirometry	W.	Echo-cardiography
S.	Thermodilution Technique	X.	Heart-volume measurement

(A) P-U;Q-V;R-X;S-W (B) P-V;Q-U;R-X;S-W

(C) P-V;Q-W;R-U;S-X (D) P-V;Q-W;R-X;S-U

Answer: (C)

16. A continuous random variable X has a probability density function $f(x) = e^{-x},\ 0<x<\infty$, then $P(X>1)$ is

(A) 0.368 (B) 0.5 (C) 0.632 (D) 1.0

Answer: (A)

17. A band limited signal with a maximum frequency of 5 kHz is to be sampled. According to the sampling theorem, the sampling frequency in kHz which is not valid is

(A) 5 (B) 12 (C) 15 (D) 20

Answer: (A)

18. The differential pressure transmitter of a flow meter using a venture tube reads 2.5×10^5 Pa for a flow rate of $0.5\ m^3/s$. The approximate flow rate in m^3/s for a differential pressure 0.9×10^5 Pa is

(A) 0.30 (B) 0.18 (C) 0.83 (D) 0.60

Answer: (A)

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19. A bulb in a staircase has two switches, one switch being at the ground floor and the other one at the first floor. The bulb can be turned ON and also can be turned OFF by anyone of the switches irrespective of the state of the other switch. The logic of switching of the bulb resembles.

(A) an AND gate (B) an OR gate (C) an XOR gate (D) a NAND gate

Answer: (C)

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20. The impulse response of a system is $h(t) = tu(t)$. For an input $u(t-1)$, the output is

(A) $\frac{t^2}{2}u(t)$ (B) $\frac{t(t-1)}{2}u(t-1)$ (C) $\frac{(t-1)^2}{2}u(t-1)$ (D) $\frac{t^2-1}{2}u(t-1)$

Answer: (C)

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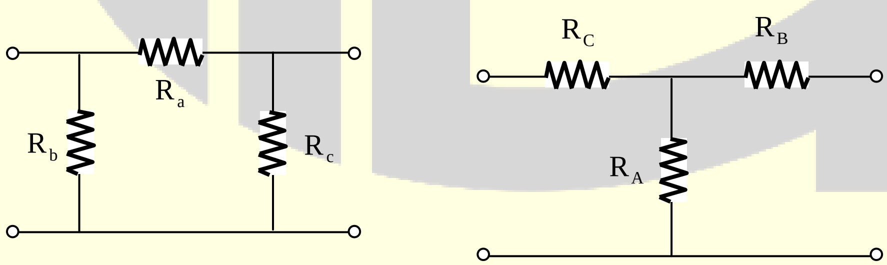
21. Consider a delta connection of resistors and its equivalent star connection as shown If all elements of the delta connection are scaled by a factor k, k > 0 the elements of the corresponding star equivalent will be scaled by a factor of



(A) k^2 (B) k (C) $1/k$ (D) $\sqrt{k}$

Answer: (B)

22. An accelerometer has input range of 0 to 10g, natural frequency 30 Hz and mass 0.001 kg. The range of the secondary displacement transducer in mm required to cover the input range is

(A) 0 to 2.76 (B) 0 to 9.81 (C) 0 to 11.20 (D) 0 to 52.10

Answer: (A)

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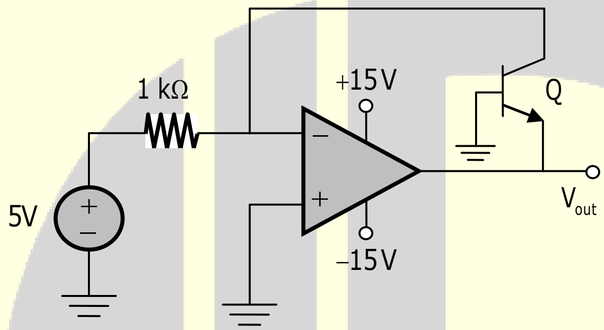
23. In the circuit shown below what is the output voltage (V_{out}) if a silicon transistor Q and an ideal op-amp are used?



(A) –15V (B) –0.7V (C) +0.7V (D) +15V

Answer: (B)

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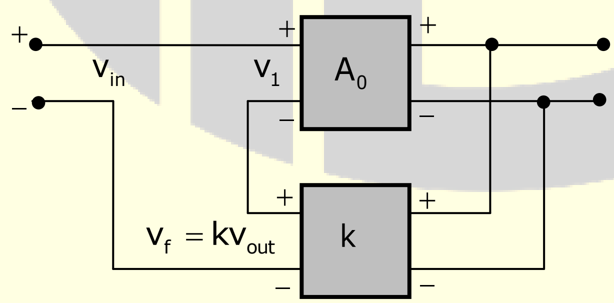
24. In the feedback network shown below, if the feedback factor k is increased, then the



(A) input impedance increases and output impedance decreases

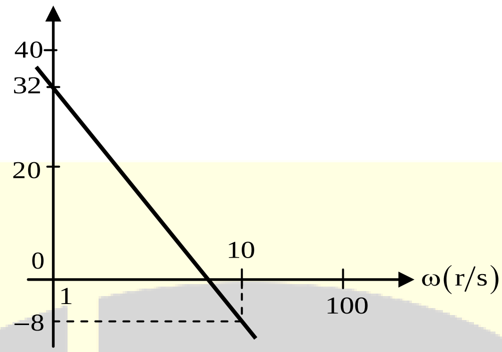
(B) input impedance increases and output impedance also increases

(C) input impedance decreases and output impedance also decreases

(D) input impedance decreases and output impedance increases

Answer: (A)

25. The Bode plot of a transfer function G(s) is shown in figure below.



The gain ($20 \log|G(s)|$) is 32 dB and -8dB at rad/s and 10 rad/s respectively. The phase is negative for all ω. Then G(s) is

(A) $\frac{39.8}{s}$ (B) $\frac{39.8}{s^2}$ (C) $\frac{32}{s}$ (D) $\frac{32}{s^2}$

Answer: (B)

Q. No. 26 – 55 Carry One Mark Each

26. While numerically solving the differential equation $\frac{dy}{dx} + 2xy^2 = 0,\ y(0) = 1$ using Euler's predictor–corrector (improved Euler–Cauchy) method with a step size of 0.2, the value of y after the first step is

(A) 1.00 (B) 1.03 (C) 0.97 (D) 0.96

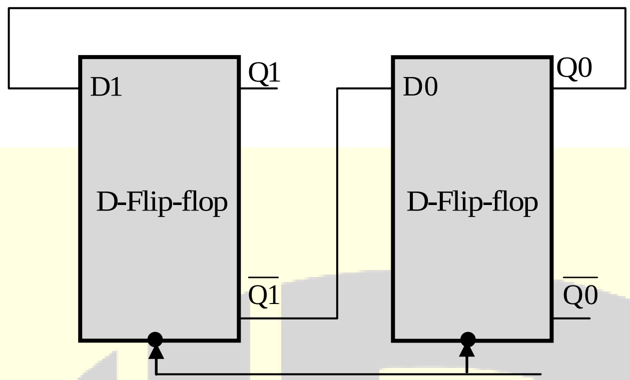
Answer: (D)

27. One pair of eigen vectors corresponding to the two eigen values of the matrix $\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$ is

(A) $\begin{bmatrix} 1 \\ -j \end{bmatrix}, \begin{bmatrix} j \\ -1 \end{bmatrix}$ (B) $\begin{bmatrix} 0 \\ 1 \end{bmatrix}, \begin{bmatrix} -1 \\ 0 \end{bmatrix}$ (C) $\begin{bmatrix} 1 \\ j \end{bmatrix}, \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ (D) $\begin{bmatrix} 1 \\ j \end{bmatrix}, \begin{bmatrix} j \\ 1 \end{bmatrix}$

Answer: (D)

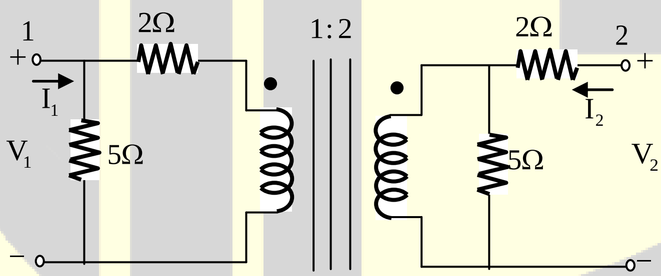
28. The digital circuit shown below uses two negative edge-triggered D-flip-flops. Assuming initial condition of Q1 and Q0 as zero, the output Q1, Q0 of this circuit is



(A) 00, 01, 10, 11, 00 …
(B) 00, 01, 11, 10, 00 …
(C) 00, 11, 10, 01, 00 …
(D) 00, 01, 11, 11, 00 …

Answer: (B)

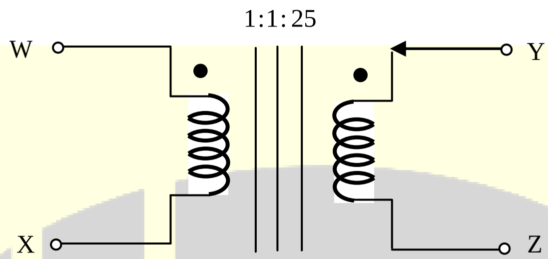
29. Considering the transformer to be ideal, the transmission parameter 'A' of the 2- port network shown in the figure below is



(A) 1.3
(B) 1.4
(C) 0.5
(D) 2.0

Answer: (A)

30. The following arrangement consists of an ideal transformer and an attenuator, which attenuates by a factor of 0.8. An ac voltage $V_{WX1} = 100V$ is applied across WX to get an open circuit voltages V_{YZ1} across YZ Next, an ac voltage $V_{YZ2} = 100V$ is applied across YZ to get an open circuit voltage V_{WX2} across WX Then, $V_{yz1} / V_{wx1}, V_{WX2} / V_{YZ2}$ are respectively,



(A) 125/100 and 80/100 (B) 100/100 and 80/100

(C) 100/100 and 100/100 (D) 80/100 and 80/100

Answer: (B)

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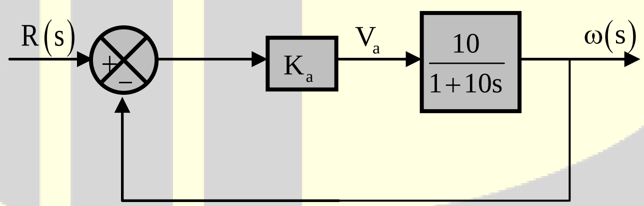
31. The open-loop transfer function of a dc motor is given as $\frac{\omega(s)}{V_a(s)} = \frac{10}{1+10s}$. When connected in feedback as shown below, the approximate value of k_a that will reduce the time constant of the closed loop system by one hundred times as compared to that of the open-loop system is



(A) 1 (B) 5 (C) 10 (D) 100

Answer: (C)

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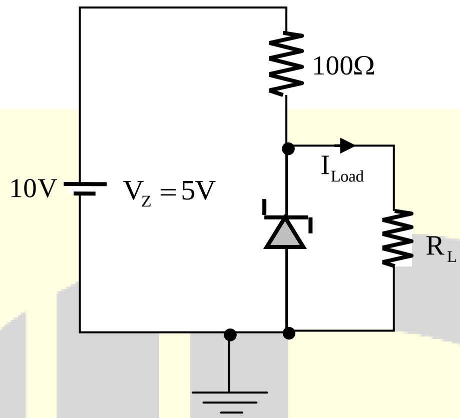
32. Two magnetically uncoupled inductive coils have Q factor q_1 and q_2 at the chosen operating frequency. Their respective resistances are R_1 and R_2. When "connected in series, the effective Q factor of the series combination at the same operating frequency is

(A) $q_1 + q_2$ (B) $(1/q_1) + (1/q_2)$

(C) $(q_1R_1 + q_2R_2)/(R_1 + R_2)$ (D) $(q_1R_2 + q_2R_1)/(R_1 + R_2)$

Answer: (C)

33. In the circuit shown below, the knee current of the ideal Zener diode is 10mA. To maintain 5V across R_L, the minimum value of R_L in Ω and the minimum power rating of the Zener diode in mW, respectively, are



(A) 125 and 125 (B) 125 and 250 (C) 250 and 125 (D) 250 and 250

Answer: (B)

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34. The impulse response of a continuous time system is given by $h(t) = \delta(t-1) + \delta(t-3)$. The value of the step response at $t = 2$ is

(A) 0 (B) 1 (C) 2 (D) 3

Answer: (B)

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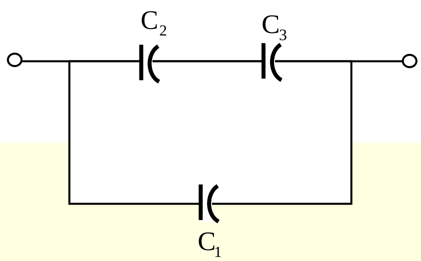
35. Signals from fifteen thermocouples are multiplexed and each one is sampled once per second with a16–bit ADC. The digital samples are converted by a parallel to serial converter to generate a serial PCM signal. This PCM signal is frequency modulated with FSK modulator with 1200 Hz as 1 and 960 Hz as 0. The minimum band allocation required for faithful reproduction of the signal by the FSK receiver without considering noise is

(A) 840 Hz to 1320 Hz (B) 960 Hz to 1200 Hz

(C) 1080 Hz to 1320 Hz (D) 720 Hz to 1440 Hz

Answer: (A)

36. Three capacitors C_1, C_2 and C_3 whose values are $10\mu F, 5\mu F, 2\mu F$ respectively, have breakdown voltages of 10V, 5V and 2V respectively.



For the interconnection shown below, the maximum safe voltage in volt as that can be applied across the combination, and the corresponding total charge in μC stored in the effective capacitance across the terminals are, respectively.

(A) 2.8 and 36 (B) 7 and 119 (C) 2.8 and 32 (D) 7 and 80

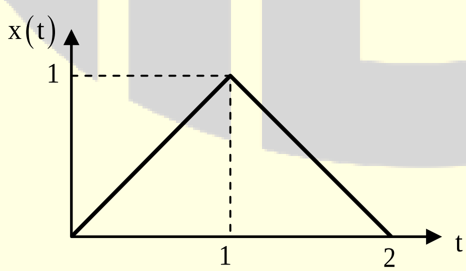
Answer: (C)

37. The maximum value of the solution y(t) of the differential equation $y(t) + \ddot{y}(t) = 0$ with initial conditions $\dot{y}(0) = 1$ and $y(0) = 2$, for $t \geq 0$ is

(A) 1 (B) 2 (C) π (D) $\sqrt{2}$

Answer: (B)

38. The Laplace transform representation of the triangular pulse shown below is

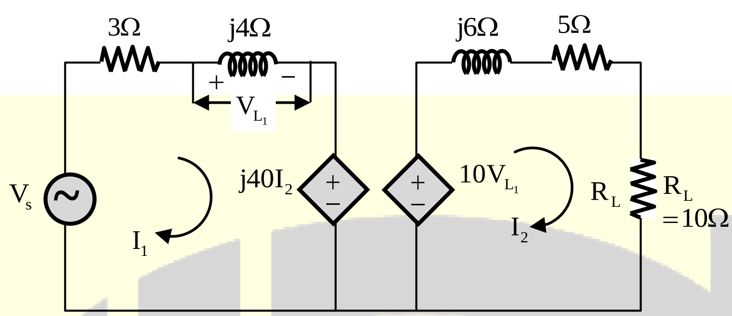


(A) $\frac{1}{s^2}\left[1 + e^{-2s}\right]$ (B) $\frac{1}{s^2}\left[1 - e^{-s} + e^{-2s}\right]$

(C) $\frac{1}{s^2}\left[1 - e^{-s} + 2e^{-2s}\right]$ (D) $\frac{1}{s^2}\left[1 - 2e^{-s} + e^{-2s}\right]$

Answer: (D)

39. In the circuit shown below, if the source voltage $V_s = 100\angle 53.13^0$ volts, then the Thevenin's equivalent voltage in volts as seen by the load resistance R_L is



(A) $100\angle 90^0$ (B) $800\angle 0^0$ (C) $800\angle 90^0$ (D) $100\angle 60^0$

Answer: (C)

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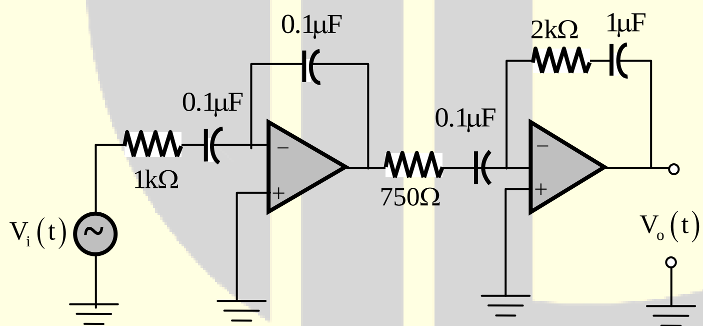
40. A signal $V_i(t) = 10 + 10\sin 100\pi t + \sin 4000\pi t + 10\sin 100000\pi t$ is supplied to a filter circuit (shown below) made up of ideal op–amps.

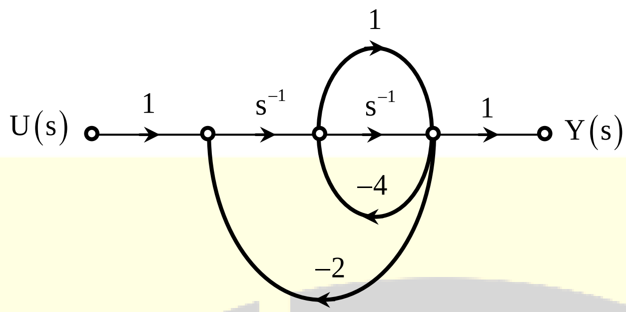


The least attenuated frequency component in the output will be

(A) 0 Hz (B) 50 Hz (C) 2 kHz (D) 50 kHz

Answer: (C)

41. The signal flow graph for a system is given below, the transfer function Y(s)/U(s) for the system is given as



(A) $\dfrac{s+1}{5s^2+6s+2}$ (B) $\dfrac{s+1}{s^2+6s+2}$ (C) $\dfrac{s+1}{s^2+4s+2}$ (D) $\dfrac{1}{5s^2+6s+2}$

Answer: (A)

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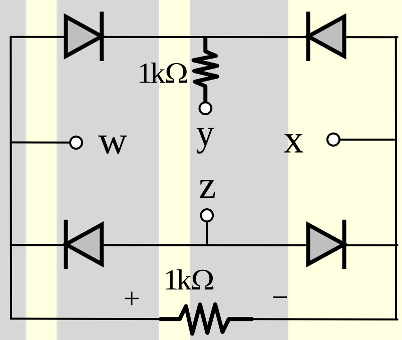
42. A voltage 1000 sin ωt Volts is applied across YZ. Assuming ideal diodes, the voltage measured across WX in Volts, is



(A) $\sin\omega t$

(B) $\left(\sin\omega t+\left|\sin\omega t\right|\right)/2$

(C) $\left(\sin\omega t-\left|\sin\omega t\right|\right)/2$

(D) 0 for all t

Answer: (D)

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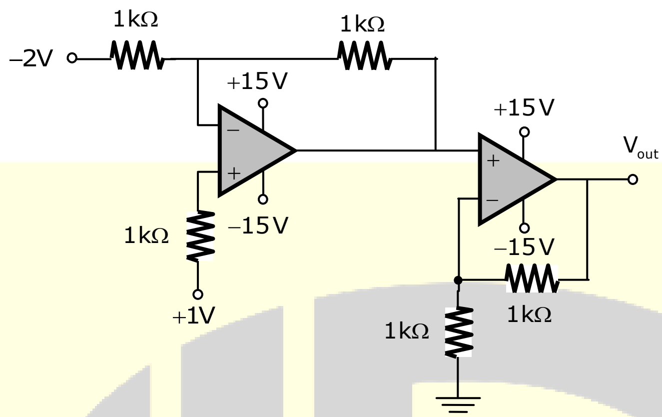
43. In the circuit shown below the op-amps are ideal. The V_{out} in Volts is



(A) 4 (B) 6 (C) 8 (D) 10

Answer: (C)

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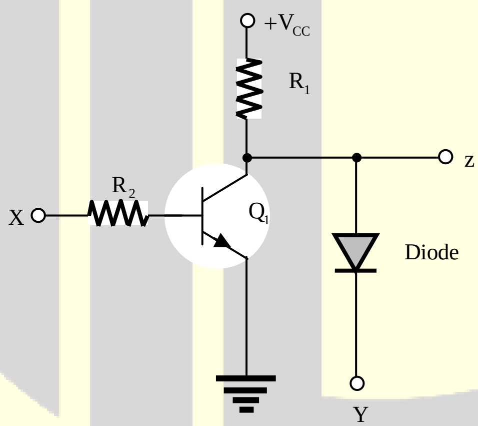
44. In the circuit shown below, Q_t has negligible collector-to-emitter saturation voltage and the diode drops negligible voltage across it under forward bias.

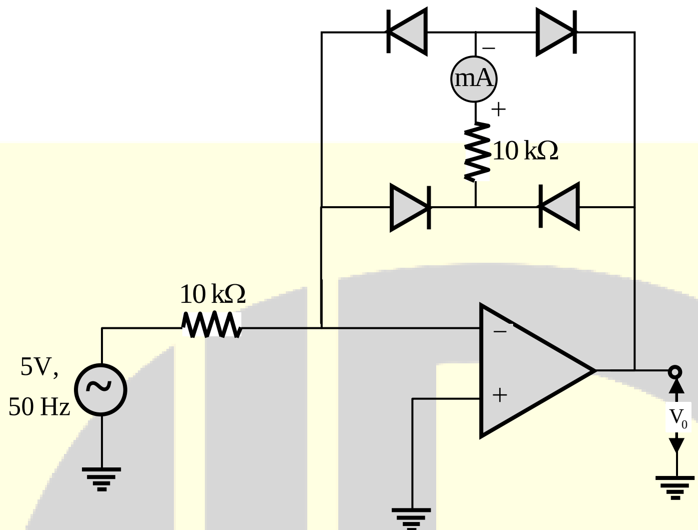


If V_{CC} is +5V, X and Y are digital signals with 0V as logic 0 and V_{CC} as logic 1, the Boolean expression for Z is

(A) XY (B) $\bar{X}Y$ (C) $X\bar{Y}$ (D) $\overline{XY}$

Answer: (B)

45. The circuit below incorporates a permanent magnet coil milli-ammeter of range 1 mA having a series resistance of $10\,k\Omega$.



Assuming constant diodes forward resistance of $50\,\Omega$, a forward diode drop of 0.7V and infinite reverse diode resistance for each diode, the reading of the meter in mA is

(A) 0.45 (B) 0.5 (C) 0.7 (D) 0.9

Answer: (A)

46. Measurement of optical absorption of a solution is disturbed by the additional stray light falling at the photo-detector. For estimation of the error caused by stray light the following data could be obtained from controlled experiments.

Photo-detector output without solution and without stray light is $500\,\mu W$

Photo-detector output without solution and with stray light is $600\,\mu W$

Photo-detector output with solution and with stray light is $200\,\mu W$

The percent error in computing absorption coefficient due to stray light is

(A) 12.50 (B) 31.66 (C) 33.33 (D) 94.98

Answer: (B)

47. Two ammeters A_1 and A_2 measure the same current and provide readings I_1 and I_2, respectively. The ammeter errors can be characterized as independent zero mean Gaussian random variable of standard deviations σ_1 and σ_2, respectively. The value of the current is computed as:

$$I = \mu I_1 + (1-\mu) I_2$$

The value of μ which gives the lowest standard deviation of I is

(A) $\frac{\sigma_2^2}{\sigma_1^2+\sigma_2^2}$ (B) $\frac{\sigma_1^2}{\sigma_1^2+\sigma_2^2}$ (C) $\frac{\sigma_2}{\sigma_1+\sigma_2}$ (D) $\frac{\sigma_1}{\sigma_1+\sigma_2}$

Answer: (A)

Common Data for Questions: 48 & 49

A tungsten wire used in a constant current hot wire anemometer has the following parameters:

Resistance at 0°C is $10\,\Omega$, Surface area is 10^{-4} m^2, Linear temperature coefficient of resistance of the tungsten wire is $4.8\times10^{-3}/°C$, Convective heat transfer coefficient is $25.2\,W/m^2/°C$, flowing air temperature is 30°C, wire current is 100 mA, mass specific heat product is $2.5\times10^{-5}\,J/°C$.

48. The thermal time constant of the hot wire under flowing air condition (in ms) is

(A) 24.5 (B) 12.25 (C) 6.125 (D) 3.0625

Answer: (B)

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49. At steady state, the resistance of the wire in ohms is

(A) 10.000 (B) 10.144 (C) 12.152 (D) 14.128

Answer: (B)

Common Data for Questions: 50 & 51

A piezo-electric force sensor, connected by a cable to a voltage amplifier, has the following parameters:

Crystal properties:

Stiffness 10^9 N/m, Damping ratio 0.01, Natural frequency 10^5 rad/s, Force-to-charge sensitivity 10^{-9} C/N, Capacitance 10^{-9} F with its loss angle assumed negligible.

Cable properties: Capacitance 2×10^{-9} F with its resistance assumed negligible.

Amplifier properties: Input impedance $1\,M\Omega$, Bandwidth 1 MHz, Gain 3.

50. The maximum frequency of a force signal in Hz below the natural frequency within in useful midband range of measurement, for which the gain amplitude is less than 1.05, approximately is

(A) 35 (B) 350 (C) 3500 (D) 16×10^{3}

Answer: (C)

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51. The minimum frequency of a force signal in Hz with its useful mid-band range of measurement, for which the gain amplitude is more than 0.95, approximately is

(A) 16 (B) 160 (C) 1600 (D) 16×10^{3}

Answer: (B)

Linked Answer Questions: Q.52 to Q.55 Carry Two Marks Each

Statement for Linked Answer Questions: 52 & 53

Consider a plant with the transfer function $G(s)=1(s+1)^{3}$. Let K_{μ} and T_{μ} be the ultimate gain and ultimate period corresponding to the frequency response based closed loop Ziegler – Nichols cycling method, respectively. The Ziegler-Nichols turning rule for a P-controller is given as $K=0.5K_{u}$

52. The values of K_{μ} and T_{μ} respectively, are

(A) $2\sqrt{2}$ and 2π (B) 8 and 2π (C) 8 and $2\pi\sqrt{3}$ (D) $2\sqrt{2}$ and $2\pi/\sqrt{3}$

Answer: (C)

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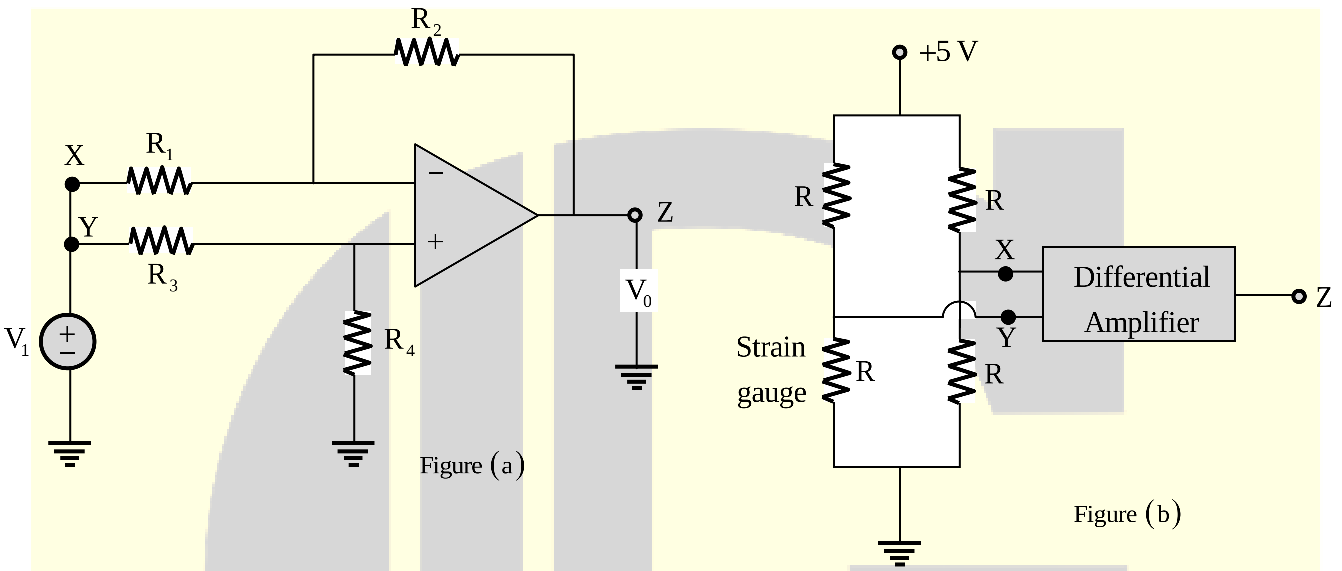
53. The gain of the transfer function between the plant output and an additive load disturbance input of frequency $\frac{2\pi}{T_{\mu}}$ in closed loop with a P-controller designed according to the Ziegler-Nichols tuning rule as given above is

(A) –1.0 (B) 0.5 (C) 1.0 (D) 2.0

Answer: (D)

Statement for Linked Answer Questions: 54 & 55

A differential amplifier with signal terminals X, Y, Z is connected as shown in figure (a) below for CMRR measurement where the differential amplifier has an additional constant offset voltage in the output. The observations obtained are: when $V_i = 2\,V,\ V_0 = 3mV,$ and when $V_i = 3\,V, V_0 = mV.$



54. Assuming its differential gain to be 10 and the op-amp to be otherwise ideal, the CMRR is

(A) 10^2 (B) 10^3 (C) 10^4 (D) 10^5

Answer: (C)

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55. The differential amplifier is connected as shown in figure (b) above to a single strain gage bridge. Let the strain gage resistance vary around its no-load resistance R by $\pm 1\%$. Assume the input impedance of the amplifier to be high compared to the equivalent source resistance of the bridge, and the common mode characteristic to be as obtained above. The output voltage in mV varies approximately from

(A) +128 to –128 (B) +128 to –122

(C) +122 to –122 (D) +99 to –101

Answer: (B)