ASSIGNMENT 3: GATE 2015 IN:INSTRUMENTATION ENGINEERING

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1) Choose the appropriate word/phrase, out of the four options given below, to complete the following sentence:
Apparent lifelessness _____ dormant life.

a) harbours b) leads to c) supports d) affects

(GATE IN 2015)

2) Fill in the blank with the correct idiom/phrase.
That boy from the town was a _____ in the sleepy village.

a) dog out of herd
b) sheep from the heap
c) fish out of water
d) bird from the flock

(GATE IN 2015)

3) Choose the statement where underlined word is used correctly.
a) When the teacher eludes to different authors, he is being elusive.
b) When the thief keeps eluding the police, he is being elusive.
c) Matters that are difficult to understand, identify or remember are allusive.
d) Mirages can be allusive, but a better way to express them is illusory.

(GATE IN 2015)

4) Tanya is older than Eric.
Cliff is older than Tanya.
Eric is older than Cliff.
If the first two statements are true, then the third statement is:
a) True
b) False
c) Uncertain
d) Data insufficient

(GATE IN 2015)

5) Five teams have to compete in a league, with every team playing every other team exactly once, before going to the next round. How many matches will have to be held to complete the league round of matches?

a) 20 b) 10 c) 8 d) 5

(GATE IN 2015)

6) Select the appropriate option in place of underlined part of the sentence.
Increased productivity necessary reflects greater efforts made by the employees.
a) Increase in productivity necessary
b) Increase productivity is necessary
c) Increase in productivity necessarily
d) No improvement required

(GATE IN 2015)

7) Given below are two statements followed by two conclusions. Assuming these statements to be true, decide which one logically follows.
Statements: I. No manager is a leader. II. All leaders are executives.
Conclusions: I. No manager is an executive. II. No executive is a manager.
a) Only conclusion I follows.
b) Only conclusion II follows.
c) Neither conclusion I nor II follows.
d) Both conclusions I and II follow.

(GATE IN 2015)

8) In the given figure angle Q is a right angle, PS:QS = 3:1, RT:QT = 5:2 and PU:UR = 1:1. If area of triangle QTS is 20 $(cm)^2$, then the area of triangle PQR in cm^2 is _____.

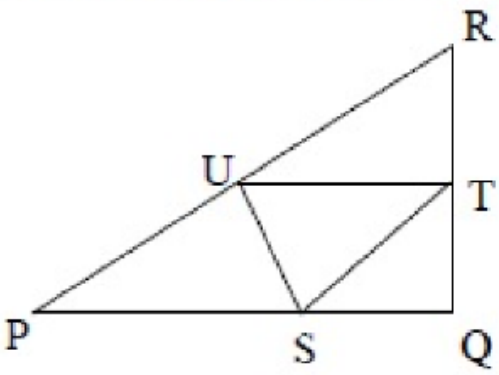

Fig. 8

(GATE IN 2015)

9) Right triangle PQR is to be constructed in the xy-plane so that the Right angle is at P and line PR is parallel to the x-axis. The x and y coordinates of P, Q, and R are to be integers that satisfy the inequalities: $-4 \leq x \leq 5$ and $6 \leq y \leq 16$. How many different triangles could be constructed with these properties?

a) 110 b) 1,100 c) 9,900 d) 10,000

(GATE IN 2015)

10) A coin is tossed thrice. Let X be the event that head occurs in each of the first two tosses. Let Y be the event that a tail occurs on the third toss. Let Z be the event that two tails occur in three tosses. Based on the above information, which one of the following statements is TRUE?

a) X and Y are not independent
b) Y and Z are dependent
c) Y and Z are independent
d) X and Z are independent

(GATE IN 2015)

11) Let A be an n× n matrix with rank r ($0 < r < n$). Then Ax = 0 has p independent solutions, where p is

a) r b) n c) n - r d) n + r

(GATE IN 2015)

12) The value of $\oint \frac{1}{z^2} dz$, where the contour is the unit circle traversed clockwise, is

a) -2πi b) 0 c) 2πi d) 4πi

(GATE IN 2015)

13) The double integral $\int_0^a \int_x^y f(x,y)dxdy$ is equivalent to

a) $\int_0^x \int_y^y f(x,y)dxdy$
b) $\int_0^a \int_x^y f(x,y)dxdy$
c) $\int_0^a \int_x^a f(x,y)dydx$
d) $\int_0^a \int_0^a f(x,y)dxdy$

(GATE IN 2015)

14) The magnitude of the directional derivative of the function $f(x,y) = x^2 + 3y^2$ in a direction normal to the circle $x^2 + y^2 = 2$, at the point (1,1), is

a) $4\sqrt{2}$ b) $5\sqrt{2}$ c) $7\sqrt{2}$ d) $9\sqrt{2}$

(GATE IN 2015)

15) The figure shows a half-wave rectifier circuit with input voltage $V(t) = 10\sin(100\pi t)$ volts. Assuming ideal diode characteristics with zero forward voltage drop and zero reverse current, the average power consumed in watts by the load resistance R_L is _____ W.

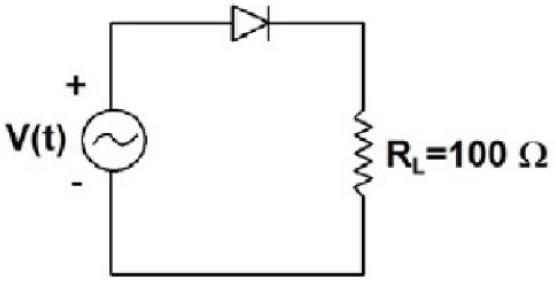

Fig. 15

(GATE IN 2015)

16) The capacitor shown in the figure is initially charged to +10 V. The switch closes at time t = 0. Then the value of $V_C(t)$ in volts at time t = 10 ms is _____ V.

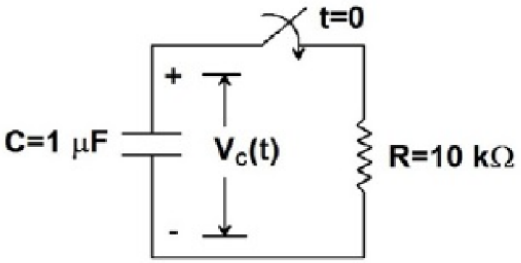

Fig. 16

(GATE IN 2015)

17) The torque transmitted by a cylindrical shaft is to be measured by using two strain gauges. The angles for mounting the strain gauges relative to the axis of the shaft for maximum sensitivity are

a) ±45° b) ±60° c) ±90° d) ±180°

(GATE IN 2015)

18) A p-type semiconductor strain gauge has a nominal resistance of 1000 Ω and a gauge factor of +200 at 25°C. The resistance of the strain gauge in ohms when subjected to a strain of $+10^{-4} m/m$ at the same temperature is ——— Ω.

(GATE IN 2015)

19) Liquid flow rate is measured using

a) a Pirani gauge
b) a pyrometer
c) an orifice plate
d) a Bourdon tube

(GATE IN 2015)

20) The output voltage of the ideal transformer with the polarities and dots shown in the figure is given by

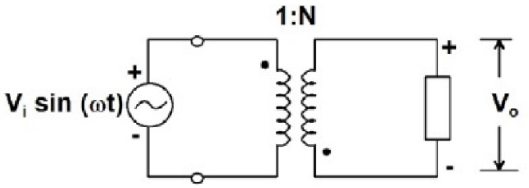

Fig. 20

a) $NV_i sin\omega t$ b) $-NV_i sin\omega t$ c) $\frac{1}{N}V_i sin\omega t$ d) $-\frac{1}{N}V_i sin\omega t$

(GATE IN 2015)

21) A load resistorR_1 is connected to a battery of voltage E with internal resistanceR_i through a resistanceR_s as shown in the figure. For fixed values ofR_1 andR_i, the value of$R_s \geq 0$ for maximum power transfer toR_1 is

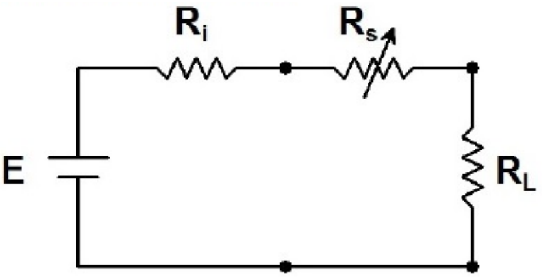

Fig. 21

a) 0 b) R_L -R_i c) R_L d) R_L +R_i

(GATE IN 2015)

22) Consider the logic circuit with input signal TEST shown in the figure. All gates in the figure shown have identical non-zero delay. The signal TEST which was at logic LOW is switched to logic HIGH and maintained at logic HIGH. The output

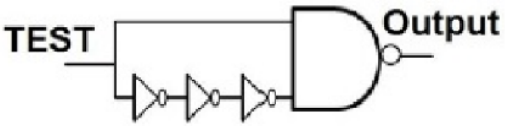

Fig. 22

a) stays HIGH throughout
b) stays LOW throughout
c) pulses from LOW to HIGH to LOW
d) pulses from HIGH to LOW to HIGH

(GATE IN 2015)

23) The logic evaluated by the circuit at the output is

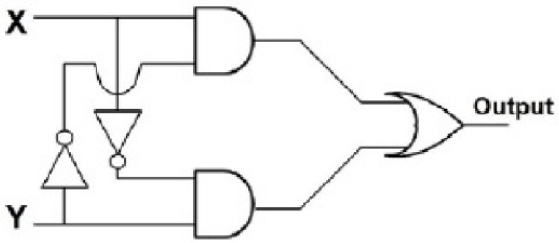

Fig. 23

a) $X\overline{Y} + Y\overline{X}$ b) $\overline{(X+Y)}XY$ c) $\overline{XY} + XY$ d) $\overline{X}Y + X\overline{Y} + X + Y$

(GATE IN 2015)

24) In the circuit shown, the switch is momentarily closed and then opened. Assuming the logic gates to have equal non-zero delay, at steady state, the logic states of X and Y are

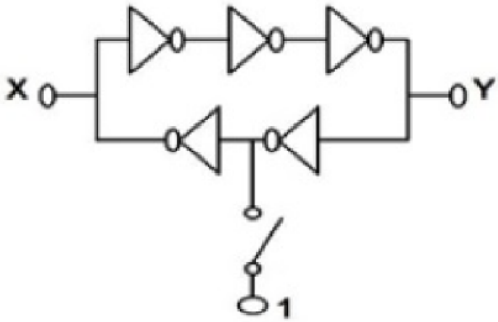

Fig. 24

a) X is latched, Y toggles continuously
b) X and Y are both latched
c) Y is latched, X toggles continuously
d) X and Y both toggle continuously

(GATE IN 2015)

25) The highest frequency present in the signal x(t) is $f_{\max}$. The highest frequency present in the signal $y(t) = x^2(t)$ is

a) $\frac{1}{f_{\max}}$ b) $f_{\max}$ c) $2f_{\max}$ d) $4f_{\max}$

(GATE IN 2015)

26) The filter whose transfer function is of the form $G(s) = \frac{s^2-bs+c}{s^2+bs+c}$ is

a) a high-pass filter
b) a low-pass filter
c) an all-pass filter
d) a band-reject filter

(GATE IN 2015)

27) Let $3 + 4j$ be a zero of a fourth order linear-phase FIR filter. The complex number which is NOT a zero of this filter is

a) $3 - 4j$ b) $\frac{3}{25} + \frac{4}{25}j$ c) $\frac{3}{25} - \frac{4}{25}j$ d) $\frac{1}{3} - \frac{1}{4}j$

(GATE IN 2015)

28) Consider the ammeter-voltmeter method of determining the value of the resistance R using the circuit shown in the figure. The maximum possible errors of the voltmeter and ammeter are known to be 1% and 2% of their readings, respectively. Neglecting the effects of meter resistances, the maximum possible percentage error in the value of R determined from the measurements, is _____%.

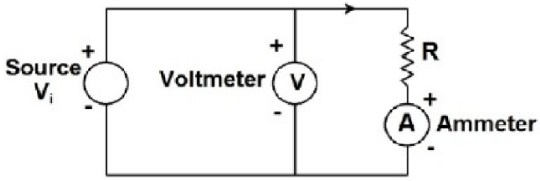

Fig. 28

(GATE IN 2015)

29) The bridge most suited for measurement of a four-terminal resistance in the range of 0.001 Ω to 0.1 Ω is

a) Wien's bridge
b) Kelvin double bridge
c) Maxwell's bridge
d) Schering bridge

(GATE IN 2015)

30) A power line is coupled capacitively through various parasitic capacitances to a shielded signal line as shown in the figure. The conductive shield is grounded solidly at one end. Assume that the length of the signal wire extending beyond the shield, and the shield resistance are negligible. The magnitude of the noise voltage coupled to the signal line is

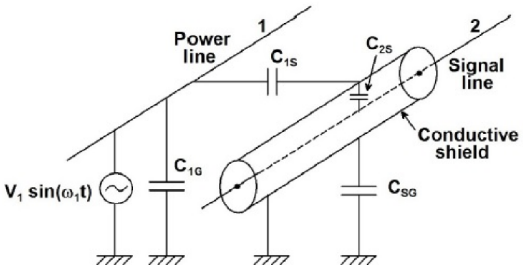

Fig. 30

a) directly proportional to C_{1G}
b) inversely proportional to the power line frequency
c) inversely proportional to C_{1S}
d) zero

(GATE IN 2015)

31) A mass-spring-damper system with force as input and displacement of the mass as output has a transfer function $G(s) = \frac{1}{(s^2+24s+900)}$. A force input F(t) = 10 sin(70t) newtons is applied at time t = 0 s. A beam from an optical stroboscope is focused on the mass. In steady state, the strobe frequency in hertz at which the mass appears to be stationary is

a) $\frac{5}{\pi}$ b) $\frac{15}{\pi}$ c) $\frac{35}{\pi}$ d) $\frac{50}{\pi}$

(GATE IN 2015)

32) A system with transfer function $G(s) = \frac{1}{s^2+1}$ has zero initial conditions. The percentage overshoot in its step response is _____%. (GATE IN 2015)

33) The voltage (E_o) developed across a glass electrode for pH measurement is related to the temperature (T) by the relation

a) $E_0 \propto \frac{1}{T^2}$ b) $E_0 \propto \frac{1}{T}$ c) $E_0 \propto T$ d) $E_0 \propto T^2$

(GATE IN 2015)

34) A light detector circuit using an ideal photo-diode is shown in the figure. The sensitivity of the photo-diode is 0.5 μA/μW. With V_r = 6 V, the output voltage V_o = -1.0 V for 10 μW of incident light. If V_r is changed to 3 V, keeping all other parameters the same, the value of V_o in volts is _____ V.

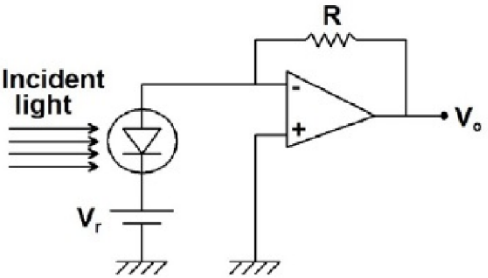

Fig. 34

(GATE IN 2015)

35) An apparatus to capture ECG signals has a filter followed by a data acquisition system. The filter best suited for this application is

a) low pass with cutoff frequency 200 Hz
b) high pass with cutoff frequency 200 Hz
c) band pass with lower and upper cutoff frequencies 100 Hz and 200 Hz for its pass band
d) band reject with lower and upper cutoff frequencies 1 Hz and 200 Hz for its stop band

(GATE IN 2015)

36) The probability that a thermistor randomly picked up from a production unit is defective is 0.1. The probability that out of 10 thermistors randomly picked up, 3 are defective is

a) 0.001 b) 0.057 c) 0.107 d) 0.3

(GATE IN 2015)

37) The probability density function of a random variable X is $p_X(x) = e^{-x}$ for $X \geq 0$ and 0 otherwise. The expected value of the function $g_X(x) = e^{3x/4}$ is _____.

(GATE IN 2015)

38) The z-transform of $x[n] = \alpha^{|n|}, 0 < |\alpha| < 1$, is X(z). The region of convergence of X(z) is

a) $|\alpha| < |z| < \frac{1}{|\alpha|}$ b) $|z| > \alpha$ c) $|z| > \frac{1}{|\alpha|}$ d) $|z| < \min[|\alpha|, \frac{1}{|\alpha|}]$

(GATE IN 2015)

39) The current in amperes through the resistor R in the circuit shown in the figure is _____ A.

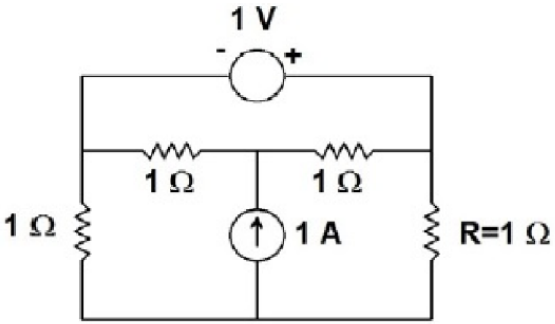

Fig. 39

(GATE IN 2015)

40) The linear I-V characteristics of 2-terminal non-ideal dc sources X and Y are shown in the figure. If the sources are connected to a 1Ω resistor as shown, the current through the resistor in amperes is _____ A.

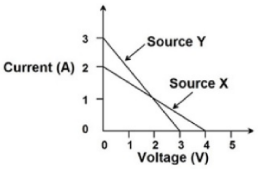

Fig. 40

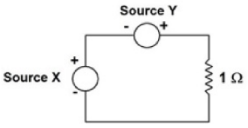

Fig. 40

(GATE IN 2015)

41) Consider the circuits shown in the figure. The magnitude of the ratio of the currents, i.e., $|I_1/I_2|$, is _____.

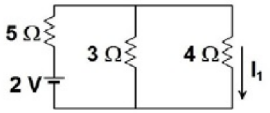

Fig. 41

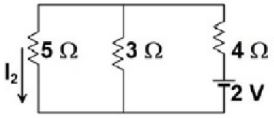

Fig. 41

(GATE IN 2015)

42) The circuit shown in the figure is in series resonance at frequency f_c Hz. The value of V_c in volts is _____ V.

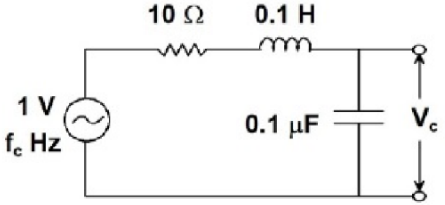

Fig. 42

(GATE IN 2015)

43) The output frequency of an LC tank oscillator employing a capacitive sensor acting as the capacitor of the tank is 100 kHz. If the sensor capacitance increases by 10%, the output frequency in kilohertz becomes _____ kHz. (GATE IN 2015)

44) The Seebeck coefficients, in μV/°C, for copper, constantan and iron, with respect to platinum, are 1.9, -38.3 and 13.3, respectively. The magnitude of the thermo emf E developed in the circuit shown in the figure, in millivolts is _____ mV.

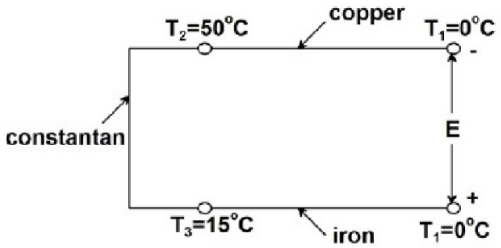

Fig. 44

(GATE IN 2015)

45) In the figure shown, R_T represents a resistance temperature device (RTD), whose characteristic is given by $R_T = R_0(1 + \alpha T)$, where R_o= 100ω, α = 0.0039 °C^{-1} and

T denotes the temperature in$^{\circ}C$. Assuming the opamp to be ideal, the value of V_0 in volts when T = 100$^{\circ}C$, is _____ V.

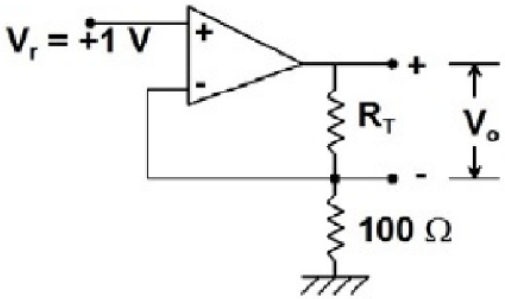

Fig. 45

(GATE IN 2015)

46) In the circuit shown in the figure, it is found that $V_{BE} = 0.7V$ and $V_E = 0V$. If $\beta_{dc} = 99$ for the transistor, then the value of R_B in kilo ohms is _____ kΩ.

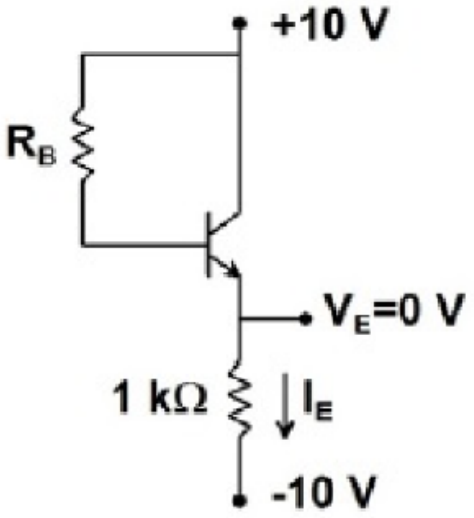

Fig. 46

(GATE IN 2015)

47) An opamp has ideal characteristics except that its open loop gain is given by the expression $A_V(s) = 10^4/(1 + 10^{-3}s)$. This op-amp is used in the circuit shown in the figure. The 3-dB bandwidth of the circuit, in rad/s, is

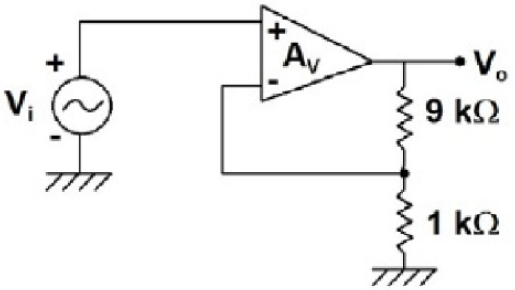

Fig. 47

a) 10^2 b) 10^3 c) 10^4 d) 10^6

(GATE IN 2015)

48) In the circuit shown, the voltage source V(t) = 15 + 0.1 sin(100t) volts. The PMOS transistor is biased such that it is in saturation with its gate-source capacitance being 4 nF and its transconductance at the operating point being 1 mA/V. Other parasitic impedances of the MOSFET may be ignored. An external capacitor of capacitance 2 nF is connected across the PMOS transistor as shown. The input impedance in mega ohm as seen by the voltage source is _____ MΩ.

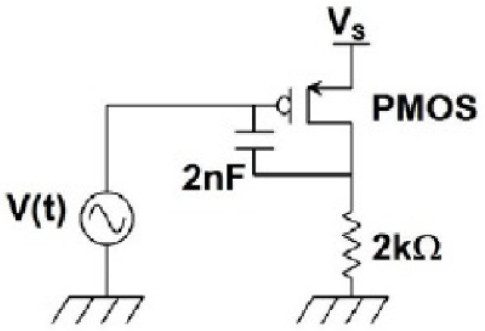

Fig. 48

(GATE IN 2015)

49) An ADC is interfaced with a microprocessor as shown in the figure. All signals have been indicated with typical notations. Acquisition of one new sample of the analog input signal by the microprocessor involves

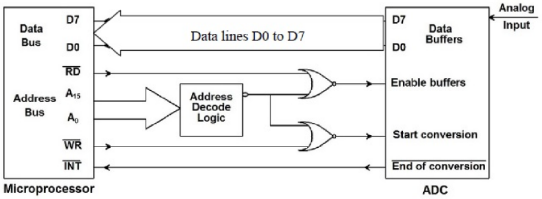

Fig. 49

a) one READ cycle only
b) one WRITE cycle only
c) one WRITE cycle followed by one READ cycle
d) one READ cycle followed by one WRITE cycle

(GATE IN 2015)

50) The number of clock cycles for the duration of an input pulse is counted using a cascade of N decade counters (DC 1 to DC N) as shown in the figure. If the clock frequency in mega hertz is f, the resolution and range of measurement of input pulse width, both in μs, are respectively,

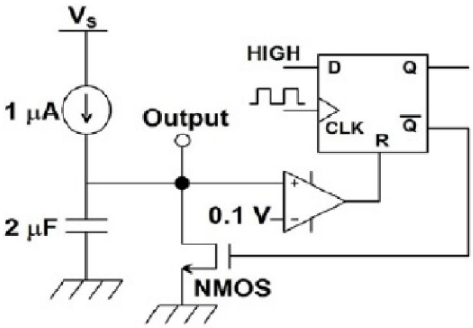

Fig. 50

a) $\frac{1}{f}$ and $\frac{(2^N-1)}{f}$ b) $\frac{1}{f}$ and $\frac{(10^N-1)}{f}$ c) $\frac{10^N}{f}$ and $\frac{(10^N-1)}{f}$ d) $\frac{2^N}{f}$ and $\frac{(2^N-1)}{f}$

(GATE IN 2015)

51) For the circuit shown in the figure, the rising edge triggered D-flip flop with asynchronous reset has a clock frequency of 1 Hz. The NMOS transistor has an ON resistance of 1000ω and an OFF resistance of infinity. The nature of the output waveform is

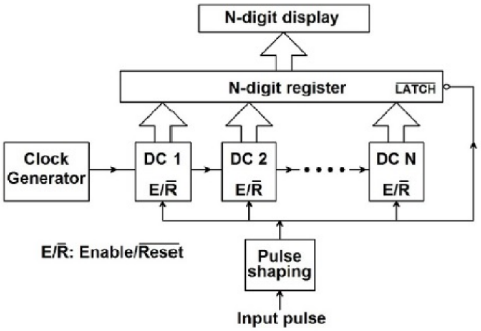

Fig. 51

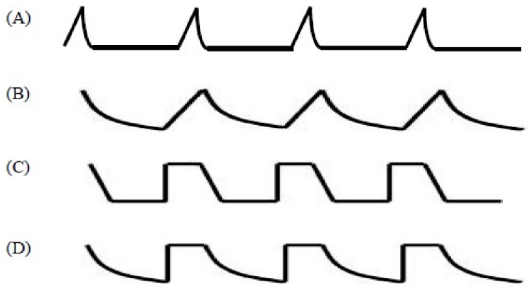

Fig. 51

(GATE IN 2015)

52) A transfer function G(s) with the degree of its numerator polynomial zero and the degree of its denominator polynomial two has a Nyquist plot shown in the figure. The transfer function represents

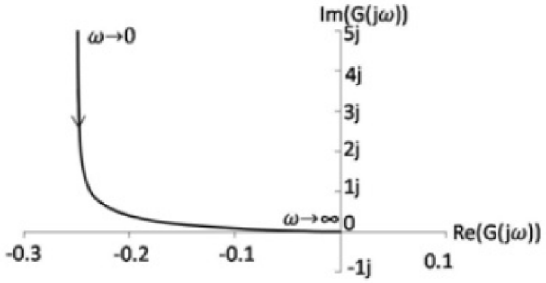

Fig. 52

a) a stable, type-0 system
b) a stable, type-1 system
c) an unstable, type-0 system
d) an unstable, type-1 system

(GATE IN 2015)

53) In the circuit shown in the figure, both the NMOS transistors are identical with their threshold voltages being 5 V. Ignoring channel length modulation, the output voltage V_{out} in volt is _____ V.

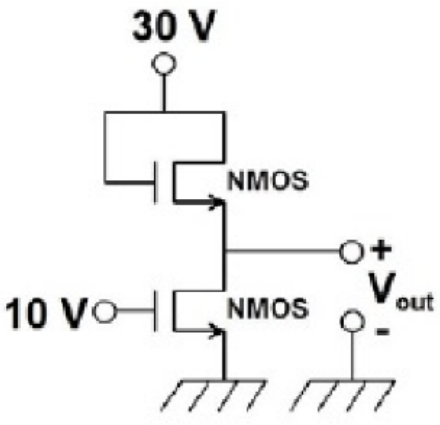

Fig. 53

(GATE IN 2015)

54) The signal x[n] = sin(πn/6)/(πn) is processed through a linear filter with the impulse response $h[n] = sin(\omega_c n)/(\pi n)$ where $\omega_c > \pi/6$. The output of the filter is

a) sin(2ω_c n)/(πn)
b) sin(πn/3)/(πn)
c) $[sin(\pi n/6)/(\pi n)]^2$
d) sin(πn/6)/(πn)

(GATE IN 2015)

55) A signal is band-limited to 0 to 12 kHz. The signal spectrum is corrupted by additive noise which is band-limited to 10 to 12 kHz. Theoretically, the minimum rate in kilohertz at which the noisy signal must be sampled so that the UNCORRUPTED PART of the signal spectrum can be recovered, is _____ kHz.

(GATE IN 2015)

56) Consider a low-pass filter module with a pass-band ripple of δ in the gain magnitude. If M such identical modules are cascaded, ignoring the loading effects, the pass-band ripple of the cascade is

a) $1 - (1 - \delta)^M$
b) δ^M
c) $(1 - \delta^M)$
d) $(1 - \delta)^M$

(GATE IN 2015)

57) The fundamental period of the signal x(t) = 2 cos(2πt/3) + cos(πt), in seconds, is _ _ _ _ _ s.

(GATE IN 2015)

58) If the deflection of the galvanometer in the bridge circuit shown in the figure is zero, then the value of R_x in ohms is _ _ _ _ _ Ω.

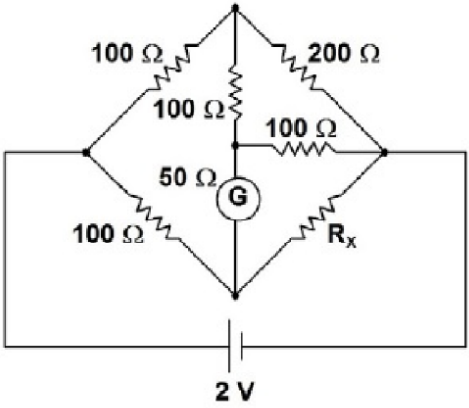

Fig. 58

(GATE IN 2015)

59) In the potentiometer circuit shown in the figure, the expression for V_x is

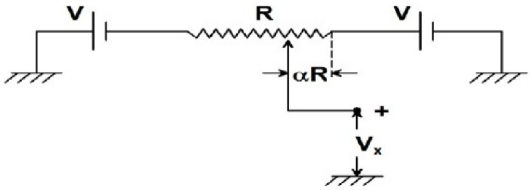

Fig. 59

a) (1 - 2α) V b) (1 - α) V c) (α - 1) V d) α V

(GATE IN 2015)

60) The open loop transfer function of a system is G(s) = $(s^2+6s+10)/(s^2+2s+2)$. The angles of arrival of its root loci are

a) $\pm\pi/4$ b) $\pm\pi/3$ c) $\pm\pi/2$ d) $\pm5\pi/6$

(GATE IN 2015)

61) A system is represented in state-space as $\dot{X} = Ax + Bu$, where $\mathbf{A} = \begin{pmatrix} 1 & 2 \\ a & 6 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$. The value of a for which the system is not controllable is _ _ _ _ _.

(GATE IN 2015)

62) A liquid level measurement system employing a radio-isotope is mounted on a tank as shown in the figure. The absorption coefficient of water for the radiation is 7.7 m^{-1}. If the height of water in the tank is reduced from 100 mm to 90 mm, the percentage change in the radiation intensity received by the detector, neglecting absorption of the radiation by air, is _____%.

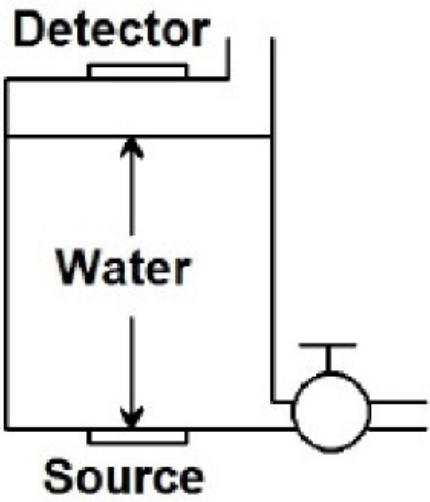

Fig. 62

(GATE IN 2015)

63) The figure shows a spot of light of uniform intensity 50 W/m² and size 10 mm× 10 mm incident at the exact center of a photo-detector, comprising two identical photo-diodes D_1 and D_2. Each diode has a sensitivity of 0.4 A/W and is operated in the photoconductive mode. If the spot of light is displaced upwards by 100 μm, the resulting difference between the photocurrents generated by D_1 and D_2 in micro amperes, is _____ μA.

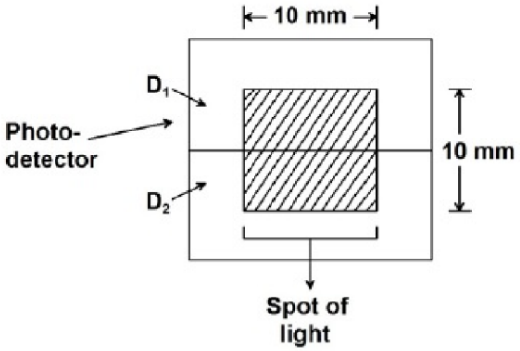

Fig. 63

(GATE IN 2015)

64) A beam of monochromatic light passes through two glass slabs of the same geometrical thickness at normal incidence. The refractive index of the first slab is 1.5 and that of the second, 2.0. The ratio of the time of passage of the beam through the first to the second slab is _____.

(GATE IN 2015)

65) The resolving power of a spectrometer consisting of a collimator, a grating and a telescope can be increased by

a) increasing the angular magnification of the telescope
b) increasing the period of the grating
c) decreasing the period of the grating
d) decreasing the slit-width of the collimator

(GATE IN 2015)