

# Gate EE-2015 SET-1

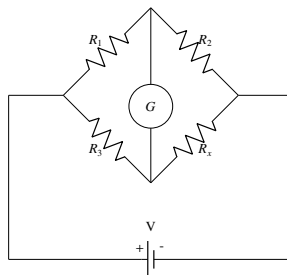
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- 1) A random variable  $X$  has probability density function  $f(x)$  as given below:

$$f(x) = \begin{cases} a + bx & \text{if } 0 < x < 1, \\ 0 & \text{otherwise} \end{cases}$$

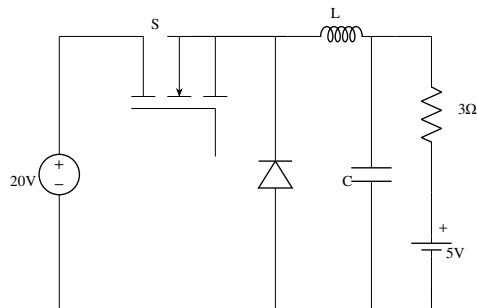
If the expected value  $E[X] = \frac{2}{3}$ , then  $\Pr[X < 0.5]$  is

- 2) If a continuous function  $f(x)$  does not have a root in the interval  $[a, b]$  then which one of the following statements is TRUE?
- $f(a) \cdot f(b) = 0$
  - $f(a) \cdot f(b) < 0$
  - $f(a) \cdot f(b) > 0$
  - $\frac{f(a)}{f(b)} \leq 0$
- 3) If the sum of the diagonal elements of a  $2 \times 2$  matrix is  $-6$ , then the maximum possible value of determinant of the matrix is \_\_\_\_\_.
- 4) Consider a function  $\vec{f} = \frac{1}{r^2} \hat{r}$  where  $r$  is the distance from the origin and  $\hat{r}$  is the unit vector in the radial direction. The divergence of this function over a sphere of radius  $R$ , which includes the origin, is
- 0
  - $2\pi$
  - $4\pi$
  - $R\pi$
- 5) When the Wheatstone bridge shown in the figure is used to find the value of resistor  $R_X$ , the galvanometer  $G$  indicates zero current when  $R_1 = 50\Omega$ ,  $R_2 = 65\Omega$  and  $R_3 = 100\Omega$ . If  $R_3$  is known with  $\pm 5\%$  tolerance on its nominal value of  $100\Omega$ , what is the range of  $R_X$  in Ohms ?

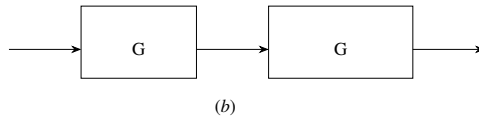
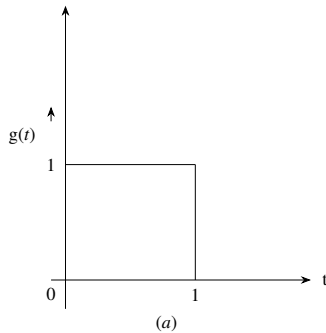


- a) [123.50, 136.50]
- b) [125.89, 134.12]
- c) [117.00, 143.00]
- d) [120.25, 139.75]

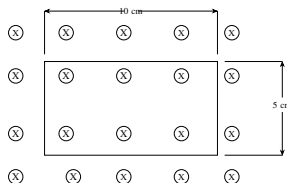
- 6) A (0 – 50A) moving coil ammeter has a voltage drop of 0.1V V across its terminals at full scale deflection. The external shunt resistance (in milliohms) needed to extend its range to (0 – 50A) is \_\_\_\_\_.
- 7) Of the four characteristics given below, which are the major requirements for an instrumentation amplifier?
- P. High common mode rejection ratio
  - Q. High input impedance
  - R. High linearity
  - S. High output impedance
- a) P, Q and R only
  - b) P and R only
  - c) P, Q and S only
  - d) Q, R and S only
- 8) In the following chopper, the duty ratio of switch S is 0.4. If the inductor and capacitor are sufficiently large to ensure continuous inductor current and ripple free capacitor voltage, the charging current (in Ampere) of the 5V battery, under steady-state, is \_\_\_\_\_.



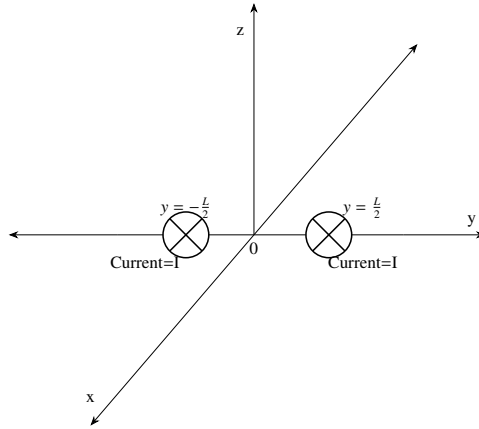
- 9) A moving average function is given by  $y(t) = \frac{1}{T} \int_{t-T}^t u(\tau) d\tau$ . If the input  $u$  is a sinusoidal signal of frequency  $\frac{1}{2T}$  Hz, then in steady state, the output  $y$  will lag  $u$  (n degree) by \_\_\_\_\_.
- 10) The impulse response  $g(t)$  of a system,  $G$ , is as shown in Figure (a). What is the maximum value attained by the impulse response of two cascaded blocks of  $G$  as shown in Figure (b) ?



- a)  $\frac{2}{3}$                       b)  $\frac{3}{4}$                       c)  $\frac{4}{5}$                       d) 1
- 11) Consider a one-turn rectangular loop of wire placed in a uniform magnetic field as shown in the figure. The plane of the loop is perpendicular to the field lines. The resistance of the loop is  $0.4\Omega$ , and its inductance is negligible. The magnetic flux density (in Tesla) is a function of time, and is given by  $B(t) = 0.25 \sin \omega t$ , where  $\omega = 2\pi \times 50 \frac{\text{radian}}{\text{second}}$ . The power absorbed (n Watt) by the loop from the magnetic field is \_\_\_\_\_.



- 12) A steady current  $I$  is flowing in the  $-x$  direction through each of two infinitely long wires at  $y = \pm \frac{L}{2}$  as shown in the figure. The permeability of the medium is  $\mu_0$ . The  $\vec{B}$ -field at  $(0, L, 0)$  is



- a)  $-\frac{4\mu_0 I}{3\pi L} \hat{z}$       b)  $+\frac{4\mu_0 I}{3\pi L} \hat{z}$       c) 0      d)  $-\frac{3\mu_0 I}{4\pi L} \hat{z}$
- 13) Consider the circuit shown in the figure. In this circuit  $R = 1\text{k}\Omega$ , and  $C = 1\mu\text{F}$ . The input voltage is sinusoidal with a frequency of 50Hz, represented as a phasor with magnitude  $V_i$  and phase angle 0 radian as shown in the figure. The output voltage is represented as a phasor with magnitude  $V_o$  and phase angle  $\delta$  radian. What is the value of the output phase angle  $\delta$  (in radian) relative to the phase angle of the input voltage?

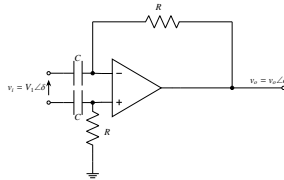


Fig. 13: Circuit diagram with capacitors, resistors, and an op-amp

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