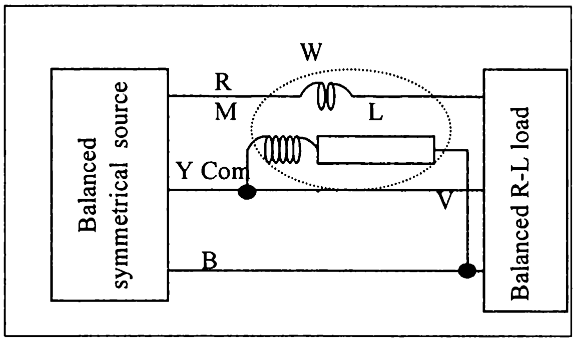


(a) The active power in the load is 1.732 kW
(b) The reactive power of the load is 1.732 kVAr
(c) The active power in the load is 3 kW
(d) The reactive power of the load is 3 kVAr

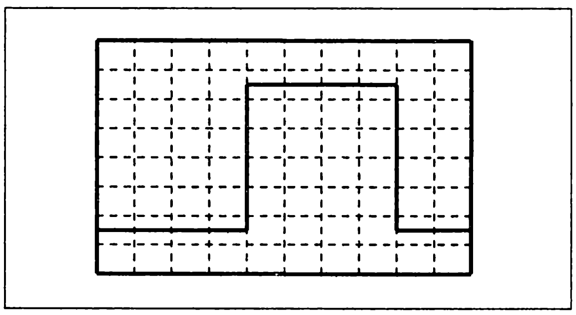
27. An unknown impedance Z is shunted across an ac current source of value 2 cos (10 t) A. The current source developed a voltage of $\sqrt{2}\,\sigma \cos\left(10t + 45^o\right)V$. The values of the impedance is.

(a) 3 Ω resistance in series with 0.3 H inductor
(b) 3 Ω resistance in parallel with 0.3 H inductor
(c) 3 Ω resistance in series with 0.3 F capacitor
(d) 3 Ω resistance in parallel with 0.3 F capacitor

28. A **Q-meter** having an insertion resistance of 0.02 Ω is used to measure the inductance of a coil. Resonance occurs at an angular frequency of 10^6 rad/s with a capacitance of 40 pF. The inductance of the coil is

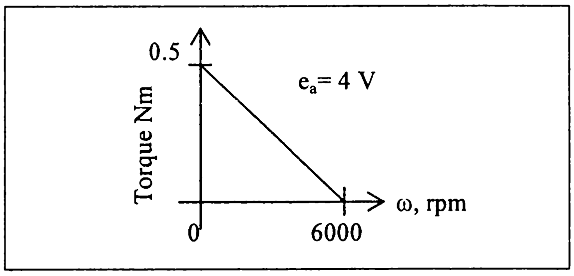
(a) 250 μH (b) 2.5 mH
(c) 25 mH (d) 0.25 H

29. A symmetrical square wave of frequency 25 kHz and a peak to peak amplitude of 10 V is fed to Y – input of a single channel **oscilloscope**. The screen appears as shown in figure. Then the X and Y sensitivities and the trigger settings respectively are



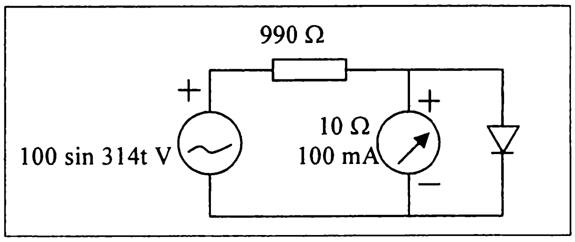
(a) 5 μs/cm, 2 V/cm and + ve slope
(b) 5 μs/cm, 2 V/cm and – ve slope
(c) 10 μs/cm, 1 V/cm and + ve slope
(d) 20 μs/cm, 2 V/cm and – ve slope

30. The torque-speed curve of a constant field armature controlled DC servomotor is shown in figure. The armature resistance in Ω and torque constant in Nm/A of the motor respectively are



(a) (1.76, 0.68) (b) (1.76, 0.85)
(c) (2.00, 0.25) (d) (0.01, 0.81)

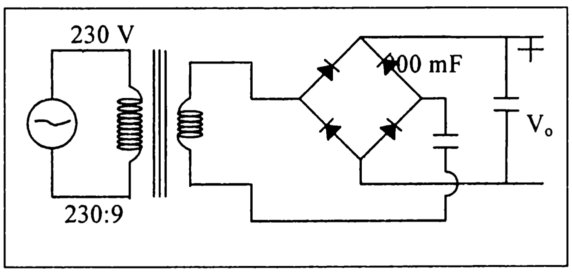
31. An ideal diode has been connected across a 10 Ω, 100 mA, center-zero PMMC meter as shown in figure. The meter will read



(a) + 100 mA (b) + 31.8 mA
(c) – 31.8 mA (d) – 67.3 mA

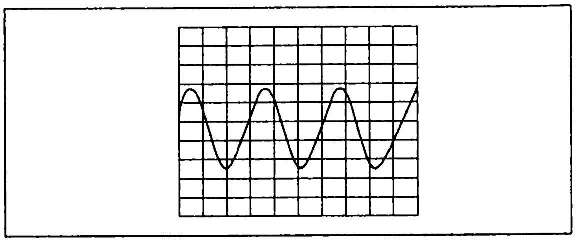
GATE – 2005 One Mark Question

32. The peak value of the output voltage V_o across the capacitor shown in the figure for a 230:9 transformer and a 230 V, 50 Hz, input, assuming 0.7 V diode drop and an ideal transformer, is



(a) 12.73 (b) 11.38
(c) 7.6 (d) 9.0

33. In the circuit shown in the given figure the input voltage $V_{in}(t)$ is given by $2\sin(100\,\pi\,t)$. For R_L in the range 0.5 kΩ to 1.5 kΩ, the current through R_L is



Which of the following figure correctly depicts the trace seen in Channel 2?

(a) P (b) Q

(c) R (d) S

Answers
Electrical and Electronic Measurements

1. Ans. (b)

Solution:

When the number of observation is less than 20, then the standard deviation of a finite number of of data having (Standard deviation) as d_1, d_2, d_3,..... d_n is expressed as

$$SD = \sqrt{\frac{d_1^2 + d_2^2 + \ldots + d_n^2}{n-1}}$$

Here, n = 2, and $d_1 = 4\ \Omega$, $d_2 = 8\ \Omega$

$$SD = \sqrt{\frac{4^2 + 3^2}{1}} = 5\,\Omega$$

2. Ans. (c)

Solution: 0.5 percent of reading

= 0.005 × 20 = 0.010 mA

$$\text{Resolution} = \frac{1}{10^n} = \frac{1}{10^3} = 10^{-3} = 0.001 = 0.1\%$$

Then worst-case error $= 0.001 + 0.101 \times 20$

$= 0.03\, mA = 3\%$

3. Ans. (b)

Solution: The fundamental units is SI system are

Unit	Name
Length	Meter
Mass	kg
Time	Second
Intensity of electric current	Ampere
Temperature	Kelvin
Luminous intensity	Candela
Amount of substance	Mole

4. Ans. (d)

Solution: Pulses/min = 5500 × 60

Then, speed in RPM

$$= \frac{5500 \times 60}{500}\left(\frac{pulse}{\min}\right)\left(\frac{revolutions}{pulse}\right)$$

$= 660$ revolution/minutes

5. Ans. (a)

Solution: Average deflection torque

$$T_d = \frac{1}{T}\int_0^T T_i\ d(\omega t)$$

Where, T_i (instantaneous torque)

$$= i_p i_v \frac{dM}{d\theta} = \left(\frac{V_p}{R_p}\right) i_v \frac{dM}{d\theta}$$

$$T_d = \frac{1}{T}\int_0^T \frac{\sqrt{2}\cos(100\pi t).\,200\sqrt{2}\sin(100\pi t)}{R_p}$$

$$\cdot\frac{dM}{d\theta}\cdot d(100\,\pi t)$$

$$= \frac{100\pi}{T}\int_0^T \frac{200\sin 200\,\pi t}{R_p}\cdot\frac{dM}{d\theta}\cdot dt$$

$$= \frac{100\pi}{R_p.T}\cdot\frac{dM}{d\theta}\int_0^T 200\sin 200\,\pi t\,.\,dt$$

= 0 [cosine average over a cycle is zero]

Second Method

$$P = \frac{1}{2\pi}\int_0^{2\pi} vi\, d\theta$$

$$P = \frac{1}{2\pi}\int_0^{2\pi}\sqrt{2}\ 200\sin(100\pi t)\times\sqrt{2}\cos(100\pi t)\,dt$$

or $$P = \frac{1}{2\pi}\int_0^{2\pi}\sqrt{2}\ 200\sin(100\pi t)\times\sqrt{2}\cos\theta\, d\theta$$

or $$P = \frac{400}{2\pi}\int_0^{2\pi}\frac{2\sin\theta\, d\theta}{2}$$

$$P = \frac{400}{2\pi}\int_0^{2\pi}\frac{1}{2}\sin 2\theta\, d\theta$$

$$P = \frac{400}{2\pi}\int_0^{2\pi}\sin 2\theta\, d\theta$$

$$P = \frac{100}{2\pi}\int_0^{2\pi}\sin 2\theta\, d\theta = 0$$

Since power consumed over one full cycle in zero for sinusoidal waveform

9. A PID controller has the transfer function $2+\frac{0.4}{s}$ with the unit of time expressed in minutes. The parameters **proportional band and reset time** for the above controller are respectively

(a) 200% and 0.4 min (b) 50% and 0.4 min.
(c) 200% and 5 min (d) 50% and 5 min.

10. For a dynamic system, various matrices for a state space model are given by. $A=\begin{pmatrix} 0 & 1 \\ -2 & -3 \end{pmatrix}$ $B=\begin{pmatrix} 0 \\ 1 \end{pmatrix}$ and C = [1 0]. The system poles are located at.

(a) –2, –1 (b) –2, –3
(c) –3, –1 (d) –1, 0

11. The transfer function of a system is given by $\frac{Y(s)}{X(s)}=\frac{e^{-0.1s}}{1+s}$. If x(t) is 0.5 sin t, then the phase angle between the output and the input will be.

(a) – 39.27° (b) – 45°
(c) – 50.73° (d) – 90°

12. The transfer function of second order band pas filter, having a centre frequency of 1000 rad./s, selectivity of 100 and a gain of 0dB at the center frequency, is

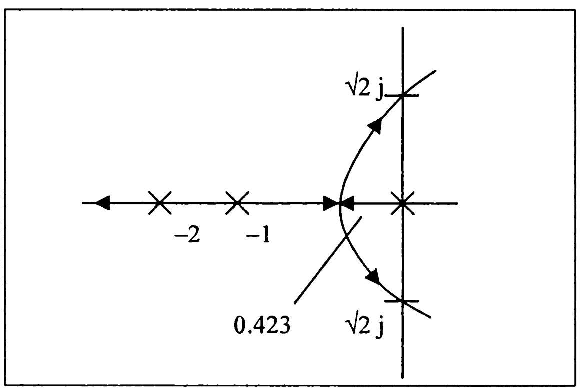
(a) $\frac{10s}{s^2+10s+10^6}$ (b) $\frac{s}{s^2+s+10^6}$

(c) $\frac{100s}{s^2+100s+10^7}$ (d) $\frac{100s}{s^2+100s+10^6}$

Data given below should be used answering questions 13 and 14.

The root locus plot of a system with transfer function $\frac{2}{s(s+1)(s+2)}$, is shown in figure. A unity feedback proportional system is built using this system.

13. The maximum possible controller gain, for which the unity feedback system is stable, is approximately.



(a) 6.0 (b) 3.0
(c) 0.4 (d) 0.2

14. The maximum possible controller gain, for which the unity feedback system exhibits a non-oscillatory response to a unit step input, is.

(a) 6.4 (b) 3.0
(c) 0.4 (d) 0.2

GATE – 2004 One Mark Question

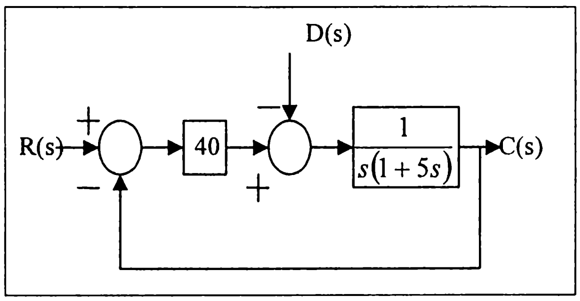
15. For a first order instrument a 5% settling time is equal to.

(a) Three times the time constant.
(b) Two times the time constant.
(c) The time constant.
(d) Time required for the output signal to reaches 5% of the final value.

16. The dominant poles of a servo system are located at s = (–2 ± j2). The damping ratio of the system is

(a) 1 (b) 0.8
(c) 0.707 (d) 0.6

17. The **steady state error** due to a unit-step disturbance input D (s) in figure is.



(a) 0 (b) 0.012
(c) 0.021 (d) 0.025

18. The **proportional band** of PI controller is 50% and the reset time is 0.2 s. The transfer function of the controller is given by

(a) $50\left(1+\frac{1}{0.2s}\right)$ (b) $50\left(1+\frac{1}{5s}\right)$

(c) $2\left(1+\frac{1}{5s}\right)$ (d) $2\left(1+\frac{1}{s}\right)$

GATE – 2004 Two Marks Questions

19. A certain system exhibited an overshoot of 16% when subjected to an input of 2u (t) where u (t) is a step input. The damping ratio and decay ratio respectively are.

19. Ans. (b)

Solution:

% of overshot = $e^{\frac{-\delta_1\pi}{\sqrt{1-\delta_1^2}}} = 0.16$

$$\frac{-\delta_1\pi}{\sqrt{1-\delta_1^2}} = \ell n\, 0.16$$

$$(\delta_1\pi)^2 = (1.83)^2(1-\delta_1^2)$$

$$\delta_1 = 0.5$$

20. Ans. (b)

Solution:

Given

$$G(s)H(s) = \frac{K}{s(s+1)(s+5)}$$

In the root locus plot the when either the roots are on the $j\omega$ axis or near to origin, then system will oscillate. Here ultimate value of gain means the value of K when root locus intersects imaginary axis at the frequency.

Characteristic equation,

$$1 + G(s)H(s) = 0$$

$$1 + \frac{K}{s(s+1)(s+5)} = 0$$

$$s(s+1)(s+5) + K = 0$$

$$s^3 + 6s^2 + 5s + K = 0$$

Apply the RH criterion array

s^3	1	5
s^2	6	K
s^1	$\frac{(30-K)}{K}$	0
s^0.	6	0

For the oscillation

$$\frac{30-K}{6} = 0$$

or, $K = 30$

The crossing point of RL on the imaginary axis are found by solving the auxiliary equation obtained from the s^2 row.

$$6s^2 + 30 = 0$$

or $6s^2 = -30$

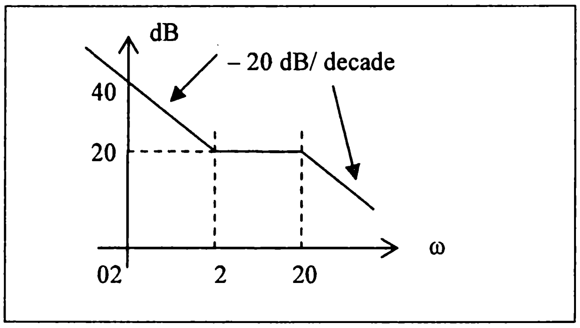
or $s^2 = -5$

or, $s = \pm j\sqrt{5}$

or, Angular frequency $\omega = \sqrt{5}$ rad/sec

21. Ans. (b)

Solution:



Since at ω = 2 rad/sec, slope changes from –20 dB/ decade, then there would be zero at ω = 2

At ω = 20 rad/sec, slope changes from 0 dB/decade, to –20 dB/decade then there would be zero at ω = 20

The slope cut vertical axis at 40 dB

The, $20\log\frac{k}{0.2} = 40 \Rightarrow \log\frac{k}{0.2} = 2$

$$\frac{k}{0.2} = 10^2 = 100$$

$$k = 0.2 \times 100 = 20$$

Hence $T(s) = \dfrac{20\left(\frac{s}{2}+1\right)}{s\left(\frac{s}{20}+1\right)}$

22. Ans. (a)

Solution:

$$T(s) = 5(1 + 0.1\,s)$$

$$T(j\omega) = 5(1 + 0.1\,j\omega)$$

$$\angle T(j\omega) = \tan^{-1}\frac{\text{Im}}{\text{Reel}} = \tan^{-1}\frac{0.1\,\omega}{1}$$

$$= \tan^{-1} 0.1\,\omega$$

At $\omega = 10$, $\angle T(j\omega) = 45^o$

At $\omega = 0$, $\angle T(j\omega) = 0^o$

23. Ans. (c)

Solution:

At phase cross frequency the phase is – 180°

$$e^{-0.1s} = e^{-sT} = e^{-j\omega T}$$

$$\angle e^{-j\omega T} = \frac{-180}{\pi}\omega T$$