Question Booklet Series: **A** *Question Booklet Serial No.* 329010

Ph. D. Entrance Test – 2015

Subject: Electrical Engineering (Instrumentation & Control)

Paper – I

Important: *Please consult your Admit Card/Roll No. slip before filling your Roll Number on the Test Booklet and Answer Sheet.*

Roll No. *In Figure* *In Words*

O.M.R. Answer Sheet Serial No.

Signature of Candidate: _____ *Signature of Invigilator:* _____

Time: 60 Minutes **Number of Questions: 50** **Maximum Marks: 50**

DO NOT OPEN THE SEAL ON THE BOOKLET UNTIL ASKED TO DO SO.

INSTRUCTIONS:

1. Write your Roll No. on the Questions Booklet and also on the OMR Answer Sheet in the space provided and nowhere else.
2. Enter the Question Booklet Serial No. on the OMR Answer Sheet. Darken the corresponding bubbles with **Black Ball Point/Black Gel Pen.**
3. Do not make any identification mark on the Answer Sheet or Question Booklet.
4. Please check that this Question Booklet contains 50 Questions. In case of any discrepancy, inform the Assistant Superintendent within 10 minutes of the start of Test.
5. Each question has four alternative answer (A,B,C,D) of which only one is correct. For each question, darken only one bubble (A or B or C or D), whichever you think is the correct answer, on the Answer Sheet with **Black Ball Point/Black Gel Pen. There shall be no negative marking for wrong answers.**
6. If you do not want to answer a question, leave all the bubbles corresponding to that question blank in the Answer Booklet. No marks will be deducted in such cases.
7. Darken the bubbles in the OMR Answer Sheet according to the Serial No. of the question given in the Question Booklet.
8. If you want to change an already marked answer, erase the shade in the darkened bubble completely.
9. For rough work only the blank sheet at the end of the Question Booklet be used.
10. The Answer Sheet is designed for computer evaluation. Therefore, if you do not follow the instructions given on the Answer Sheet, it may make evaluation by the computer difficult. **Any resultant loss to the candidate on the above account, i.e. not following the instructions completely, shall be of the candidate only.**
11. After the test, hand over the Question Booklet and the Answer Sheet to the Assistant Superintendent on duty.
12. In no case the Answer Sheet, the Question Booklet, or its part or any material copied/noted from this Booklet is to be taken out of the examination hall. Any candidate found doing so would be expelled from the examination.
13. A candidate who creates disturbance of any kind or changes his/her seat or is found in possession of any paper possibly of any assistant or found giving or receiving assistant or found using any other unfair means during the examination will be expelled from the examination by the Centre Superintendent/Observer whose decision shall be final.
14. **Communication equipment such as mobile phones, pager, wireless set, scanner, camera or any electronic/digital gadget etc., is not permitted inside the examination hall. Use of calculators is not allowed.**
15. The candidates will not be allowed to leave the Examination Hall/Room before the expiry of the allotted time.

1. A meter having a sensitivity of 2kΩ/V is used for the measurement of voltage across a circuit having an output resistance of 1kΩ and an open circuit voltage of 8V. What will be the reading of the meter at its 10v scale?

A) 5.72V B) 6.51V C) 7.62 V D) 7.91

2. A Thermometer is calibrated from 150°C to 200°C. The accuracy specified is ±0.25%. The maximum static error in measurement is

A) ±0.5°C B) 0.375°C C) ±0.125°C D) +0.0125°C

3. A Wheatstone bridge requires a change of 6Ωin the unknown branch of the bridge to produce a change in deflection on 3mm of galvanometer. The sensitivity of the instrument is

A) 0.5% B) 2% C) 2.0mm/Ω D) 0.5 mm/Ω

4. The total current $I = I_1 + I_2$ in a circuit is measured as $I_1 = 150 \pm 1A$ and $I_2 = 250 \pm 2A$, where the limits of error are given as standard deviations. It measured as

A) (400±3)A B) (400±2.4)A C) (400±1.5)A D) (400±1)A

5. Decide whether each of these statements is True (T) or False (F). Sensors in a measurement system have: (i) An input of the variable being measured, (ii) An output of a signal in a form suitable for further processing in the measurement system. Which option BEST describes the two statements?

A) (i) T (ii) T B) (i) T (ii) F
C) (i) F (ii) T D) (i) F (ii) F

6. The following lists the types of signals that occur in sequence at the various stages in a particular measurement system: (i) Temperature (ii) Voltage (iii) Bigger voltage (iv) movement of pointer across a scale.
The signal processor is the functional element in the measurement system that changes the signal from:

A) (i) to (ii) B) (ii) to (iii)
C) (iii) to (iv) D) (ii) to (iv)

7. Decide whether each of these statements is True (T) or False (F). The discrepancy between the measured value of the current in an electrical circuit and the value before the measurement system, an ammeter, was inserted in the circuit is bigger the larger: (i) The resistance of the meter, (ii) The resistance of the circuit. Which option BEST describes the two statements?

A) (i) T (ii) T B) (i) T (ii) F
C) (i) F (ii) T D) (i) F (ii) F

8. Decide whether each of these statements is True (T) or False (F). A highly reliable measurement system is one where there is a high chance that the system will: (i) Require frequent calibration. (ii) Operate to the specified level of performance. Which option BEST describes the two statements?

A) (i) T (ii) T
B) (i) T (ii) F
C) (i) F (ii) T
D) (i) F (ii) F

9. Decide whether each of these statements is True (T) or False (F). A measurement system which has a lack of repeatability is one where there could be: (i) Random fluctuations in the values given by repeated measurements of the same variable. (ii) Fluctuations in the values obtained by repeating measurements over a number of samples.
Which option BEST describes the two statements?

A) (i) T (ii) T
B) (i) T (ii) F
C) (i) F (ii) T
D) (i) F (ii) F

10. A copper-constantan thermocouple is to be used to measure temperatures between 0 and 200°C. The e.m.f. at 0°C is 0 mV, at l00°C it is 4.277 mV and at 200°C it is 9.286 mV. If a linear relationship is assumed between e.m.f. and temperature over the fiill range, the non-linearity error at 100°C is:

A) -3.9T
B) -7.9T
C) +3.9T
D) +7.9T

11. The change in resistance of an electrical resistance strain gauge with a gauge factor of 2.0 and resistance 50 Ω when subject to a strain of 0.001 is:

A) 0.0001 Ω
B) 0.001 Ω
C) 0.01 Ω
D) 0.1 Ω

12. An incremental shaft encoder gives an output which is a direct measure of
A) The absolute angular position of a shaft
B) The change in angular rotation of a shaft
C) The diameter of the shaft
D) The change in diameter of the shaft

13. A pressure sensor consisting of a diaphragm with strain gauges bonded to its surface has the following information in its specification:
Range: 0 to 1000 kPa
Non-linearity error: ±0.15% of full range
Hysteresis error: ±0.05% of full range
The total error due to non-linearity and hysteresis for a reading of 200 kPa is:

A) ±0.2 kPa
B) ±0.4 kPa
C) ±2kPa
D) ±4kPa

14. A pneumatic cylinder has a piston of cross-sectional area 0.02 m^2 The force exerted by the piston when the working pressure applied to the cylinder is 2 MPa will be:

A) 100 MN
B) 40MN
C) 40kN
D) 20kN

15. A hydraulic cylinder with a piston having a cross-sectional area of 0.01 m^2 is required to give a workpiece an average velocity of 20 mm/s. The rate at which hydraulic fluid should enter the cylinder is:

A) 4×10^{-6} m^3/s B) 2×10^{-4} m^3/s C) 0.2 m^3/s D) 2 m^3/s

16. A flow control valve has a diaphragm actuator. The air pressure signals from the controller to give 0 to 100% correction vary from 0.02 MPa to 0.1 MPa above the atmospheric pressure. The diaphragm area needed to 100% open the control valve if a force of 400 N has to be applied to the stem to fully open the valve is:

A) 0.020 m^3 B) 0.016 m^3 C) 0.004 m^3 D) 0.005 m^3

17. A flow control valve with a linear plug gives a minimum flow rate of 0 and a maximum flow rate of 10 m^3/s. It has a stem displacement at full travel of 20 mm and so the flow rate when the stem displacement is 5 mm is:

A) 0.0 m^3/s B) 2.5 m^3/s C) 5.0 m^3/s D) 7.5 m^3/s

18. A flow control valve with an equal percentage plug gives a flow rate of 0.1 m^3/s when the stem displacement is 0 and 1.0 m^3/s when it is at full travel. The stem displacement at full travel is 30 mm. The flow rate with a stem displacement of 15 mm is:

A) 0.32 m^3/s B) 0.45 m^3/s C) 1.41 m^3/s D) 3.16 m^3/s

19. A closed-loop control system has a forward loop with a transfer function of $3/(s + 2)$ and a negative feedback loop with a transfer function of 5. The overall transfer function of the system is:

A) $5 + 3/(s + 2)$ B) $5(s + 2)/3$ C) $3/(s + 17)$ D) $15/(s + 2)$

20. An open-loop control system consists of a d.c. motor with a transfer function of $2/(0.5s+2)$ and a process, its shaft and load, with a transfer function of $1/(0.1s + 0.5)$. The overall transfer function of the system is:

A) $2/[(0.5s + 20)(0.1s + 0.5)]$ B) $[2/(0.5s+ 2)]+ [1/(0.1s +0.5)]$
C) $2(0.1s + 0.5)/0.5s + 2)$ D) $(0.5s + 2)(0.1s + 0.5)/2$

21. The Laplace transform of the time function $t\,e^{-3t}$ is

A) $3/(s(s-3))$ B) $3/(s(s+3))$ C) $1/(s-3)^2$ D) $1/(s+3)^2$

22. The time function corresponding to the Laplace transform $5/(s + 3)$ is:

A) $5e^{3t}$ B) $5e^{-3t}$ C) $3e^{5t}$ D) $3e^{-5t}$

23. A system has a transfer function of $1/(s + 3)$. When subject to a unit impulse input, the output of the system will have the Laplace transform:

A) $1/(s + 3)$ B) $s/(s+3)$ C) $1/(s(s+3))$ D) $(s + 3)/1$

24. The steady-state error for a step input with a proportional control system is, when steady-state conditions occur:

A) The magnitude of the final output
B) The error input to the controller
C) The initial size of the step input
E) The difference between the final output and the step input

25. A proportional controller of gain K is used with a system with a transfer function 4/(25+1) and a unity negative feedback loop. The closed-loop transfer function is:

A) 4K/(2s+l) B) 4K/(2s + 5) C) K(25+1)/ 4 D) 4K(2s-3)

26. 0 Decide whether each of these statements is True (T) or False (F).

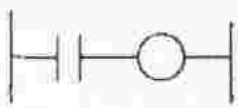

Figure above shows a ladder diagram rung for which: (i) The input contacts are normally open. (ii) There is an output when there is an input to the contacts.

A) (i) T (ii) T B) (i) T (ii) F
C) (i) F (ii) T D) (i) F (ii) F

27. Decide whether each of these statements is True (T) or False (F).

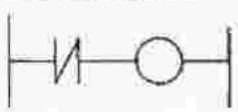

Figure above shows a ladder diagram rung for which:
(i) The input contacts are normally open.
(ii) There is an output when there is an input to the contacts.

A) (i) T (ii) T B) (i) T (ii) F
C) (i) F (ii) T D) (i) F (ii) F

28. Decide whether each of these statements is True (T) or False (F).

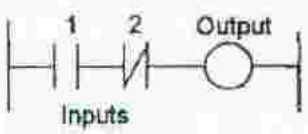

Figure above shows a ladder diagram rung for which:
(i) When only input 1 contacts are activated, there is an output.
(ii) When only input 2 contacts are activated, there is an output.

A) (i) T (ii) T B) (i) T (ii) F
C) (i) F (ii) T D) (i) F (ii) F

29. Decide whether each of these statements is True (T) or False (F).

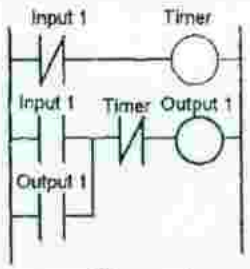

Figure A

When there is an input to Input 1 in Figure A, the output is switched:

(i) On for the time for which the timer was pre-set.

(ii) OffFfor the time for which the timer was pre-set.

A) (i) T (ii) T B) (i) T (ii) F C) (i) F (ii) T D) (i) F (ii) F

30. Decide whether each of these statements is True (T) or False (F). When there is an input to Input 1 in Figure A:

(i) The timer starts.

(ii) There is an output from Output 1.

A) (i) T (ii) T B) (i) T (ii) F C) (i) F (ii) T D) (i) F (ii) F

31. Decide whether each of these statements is True (T) or False (F). The timer in Figure A starts when: (i) There is an output, (ii) The input ceases.

A) (i) T (ii) T B) (i) T (ii) F C) (i) F(ii) T D)(i) F (ii) F

32. Decide whether each of these statements is True (T) or False (F).

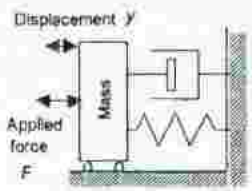

Figure. B

For the model in Figure B: (i) The resistive force which has to be overcome for the dashpot is proportional to the acceleration experienced by it. (ii) The resistive force which has to be overcome for the spring is proportional to its extension > / .

A) (i) T (ii) T B) (i) T (ii) F C) (i) F(ii) T D) (i) F (ii) F

33. Decide whether each of these statements is True (T) or False (F). For the model in Figure B: (i) The equation for dynamic conditions relating the output y and the input F is a second-order differential equation. (ii) The steady-state gain of the system depends only on the constant of proportionality relating the force acting on the spring and its extension, i.e. the spring stiffness.

A) (i) T (ii) T B) (i) T (ii) F C) (i) F (ii) T D) (i) F (ii) F

34. For a rotational system, the output θ is related to the input T by the differential equation:

$$I\frac{d^2\theta}{dt^2} + c\frac{d\theta}{dt} + k\theta = T$$

For the system to be critically damped, we must have:

A) c = I B) c = k C) c = kI D) $c = 2\sqrt{(kI)}$

35. For a system which can be represented by a second-order differential equation relating its input and output, for a step input to give an output which rises to the steady-state value ith no oscillations about the steady-state value and take the minimum amount of time, the damping constant has to be:

A) = Zero B) < 1 C) = 1 D) > 1

36. An LVDT is impressed upon 6.3V input and it produces 5.2 V for a range of ±0.25inch. When the core is - 0.25 inch from the centre, what will be the output?

A) -2.0V B) +2.0V C) -2.6V D)+2.6V

37. The root locus of the functions (i) $1/(s+1)^2$ (ii) $1/(s^2+4s+8)$

A) For (i) exponentional increasing , for (ii) oscillatory increasing
B) For (i) exponentional decreasing, for (ii) oscillatory increasing
C) For (i) exponentional decreasing, for (ii) oscillatory decreasing
D) For (i) exponentional decreasing, for (ii) oscillatory increasing

38. For type-2 system the steady state error due to step input is equal to

A) Infinity B) Finite C) zero D) None of these

39. To obtain high accuracy requirements, we use

A) Integral control B) Proportional control
C) Derivative control D) None of these

40. For a constant M circle the centre will lie at $[\,[M^2/(1-M^2),0]$ in G-plane and has a radius of

A) M B) $\frac{M}{1-M^2}$ C) $1-M^2$ D) $\frac{M}{1+M^2}$

41. Phase lag network

A) Maintains constant velocity gain B) Decreases bandwidth
C) Increases system stability D) All of these

42. The value of A matrix in $\dot{X} = AX$ for the system described by the differential equation $\ddot{y} + 2\dot{y} + 3y = 0$ is

A) $\begin{bmatrix} 1 & 0 \\ -2 & -1 \end{bmatrix}$ B) $\begin{bmatrix} 1 & 0 \\ -1 & -2 \end{bmatrix}$ C) $\begin{bmatrix} 0 & 1 \\ -2 & 1 \end{bmatrix}$ D) $\begin{bmatrix} 0 & 1 \\ -3 & -2 \end{bmatrix}$

43. A linear time invariant system initially at rest, when subjected to a unit step input, gives a response $y(t) = te^{-t}, t > 0$. The transfer function of the system is,

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

44. The unit step response of a particular control system is given by $c(t) = 1 - 10e^{-t}$. Then its transfer function is

A) $\frac{10}{s+1}$ B) $\frac{s-9}{s+1}$ C) $\frac{1-9s}{s+1}$ D) $\frac{1-9s}{s(s+1)}$

45. The characteristic equation $s^3 + 3s^2 + 3s + k = 0$ is stable for which value of k?

A) -6 B) 15 C) 5 D) 12

46. None of the poles of a linear control system lies in the right half of s plane. For a bounded input, the output of this system

A) Is always bounded
B) Could be unbounded
C) Always tends to zero
D) None of these

47. A unity feedback system has transfer function $G(s) = \frac{K}{s(s+1)(s+2)}$. In the root-locus, the break away point occurs between

A) S=0 and -1
B) s=-1 and –infinity
C) s=-1 and -2
D) s=-2 and –infinity

48. A signal of 10mV is to be measured at 75MHz, which of the following instruments can be used?

A) VTVM
B) CRO
C) Moving iron voltmeter
D) Digital multmeter

49. The characteristic equation of a closed loop system is given by $s^2 + 4s + 16 = 0$. The resonant frequency in radians/sec of the system is

A) 2 B) $2\sqrt{3}$ C) 4 D) $2\sqrt{2}$

50. The radial distance between a pole and origin gives

A) Damped frequency of oscillations
B) Damping ratio
C) Time constant
D) Natural frequency of oscillation

x-x-x