০৮/০৯/২৫- IPE- 301 বিকাল

L3-/T-I/IPE

Date: 04/09/2025

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-I B.Sc. Engineering Examinations 2023-2024

Sub: **IPE 301 (Measurement, Instrumentation & Control)**

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Assume appropriate value for any missing value.

1. (a) Derive an expression of the effective diameter of a thread with the two-wire method. A metric screw thread is being inspected using the two-wire method to measure its effective diameter, and the following data is generated: pitch = 1.5 mm, diameter of the best size wire = 0.866 mm, distance over the wires = 26.58 mm, and thread angle = 60°. Determine the effective diameter of the screw thread. **(20)**

(b) Is the major diameter of a screw thread larger than the minor diameter for both external and internal thread? Justify your answer with a figure. **(10)**

(c) Explain the Hysteresis error with an example. **(5)**

2. (a) Describe the traditional and advanced features that differentiate an instrumentation system from a measurement system. Are all sensors a type of transducers? Justify your answer. **(20)**

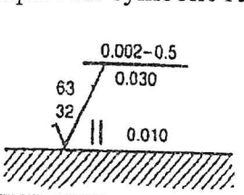
(b) If the base pitch is 8.86 mm and the radius of the base circle is 33.83 mm, determine the number of teeth of the gear. Why dedendum is larger than addendum for a gear? Explain with necessary figures. **(10)**

(c) Draw different lay directions with symbols. **(5)**

3. (a) What are the differences between destructive and nondestructive testing (NDT)? Which NDT method is being used to detect surface or subsurface flaws, as well as to assess conductivity and coating thickness? Write a short note on this NDT method. **(20)**

(b) Calculate the limits of tolerance and allowance for a 29 mm shaft and hole pair designated H_8h_8, where the fundamental tolerance is 25 times of the tolerance factor and diameter step is between 18 to 30 mm. **(10)**

(c) Identify and interpret the symbolic representations of the following figure. **(5)**



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4. (a) Justify the statement "The output given by a measurement system may not be the true value". What are the possible errors leading to such deviation? Explain with examples. **(20)**

(b) Describe the working principle of a stylus probe instrument with necessary figure. **(10)**

(c) Why ultrasonic inspection non-destructive testing method does not perform well in case of extremely thin material? **(5)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE** questions.

5. (a) A system has transfer function of $\frac{10}{s^2+4s+9}$. What will be its damped natural frequency, rise time, and peak time? Is the system under-damped, critical damped or over-damped? **(8)**

(b) **(20)**

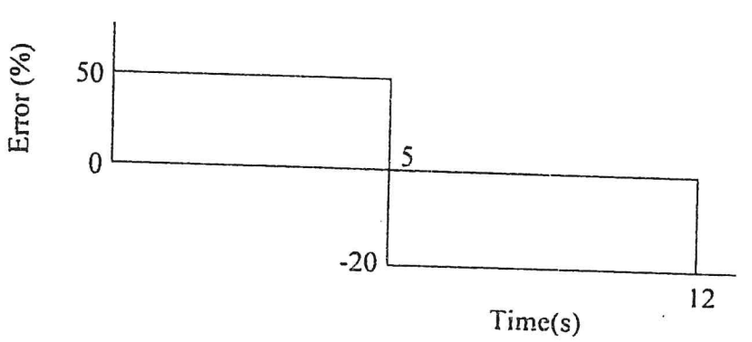

Figure: 1

Figure: 1 shows how the controller output will vary with time for the error signal with respect to time. When the controller operates as

(i) proportional with $k_p = 5$
(ii) Derivative with $k_d = 2s$
(iii)PI ($k_i = 0.5\ s^{-1}$)
(iv)PD
(v) PID

(c) The input x and output y of a system are described by: **(7)**

$$\frac{dy}{dx} + 2y = x$$

Determine how the output will vary with time when there is an input which starts at zero time and then increases at the constant rate of 6 units/s. The initial output is zero.

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6. (a) Define each of the following control systems. Provide one example of each and draw their corresponding block diagrams. **(15)**

(i) Discrete-time control system

(ii) Digital control system

(iii) Hierarchical control system

(b) An automatic pump system is to be designed for a residential building with one overhead tank and one underground tank. When the overhead tank gets empty and there is a minimum level of water in the underground tank, the pump will tum ON automatically. Again, when the overhead tank gets full or the underground tank gets empty, the pump will turn OFF. Draw logic network diagram, truth table, ladder logic diagram of the system. **(15)**

(c) Briefly discuss On-off controller with a dead band. **(5)**

7. (a) The input x and output y of a system are described by: **(10)**

$$\frac{d^2y}{dt^2}+5\frac{dy}{dx}+16y=16x$$

If initially the input and output are zero, what will be the output when there is a unit impulse input?

(b) Consider a fluid storage tank which starts when button X1 is depressed, this energizes the control relay C1. In turn this energizes solenoid S1, which opens a valve allowing fluid to flow into the tank. When the tank becomes full, the float switch FS closes, which opens relay C1, causing the solenoid S1 to be de-energized, thus turning off the in-flow. Switch FS also activates a second relay C2 which energize timer T1 to provide a 90 sec delay for a certain chemical reaction to occur in the tank. At the end of the delay time, the timer energizes two devices: It energizes solenoid S2, which opens a valve to allow the fluid to flow out of the tank; and it initiates timer T2, which waits 120 sec to allow the contents of the tank to be drained. At the end of the 120 sec, the timer breaks the current by deactivating relay C2 and de-energizes solenoid S2, thus closing the outflow valve. Construct a "ladder logic diagram" for the system. **(15)**

(c) Draw the truth tables for the logic network diagrams shown in the following figure. Also draw the ladder logic diagram. **(10)**

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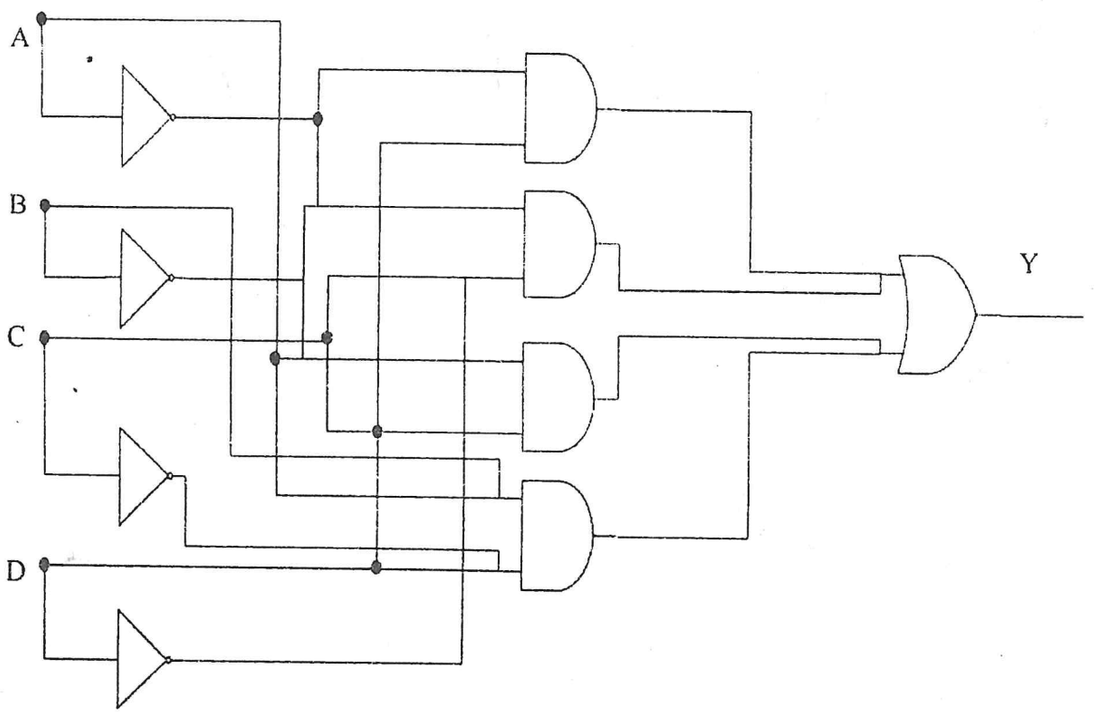

8. (a) Explain the different categories of surface irregularities. Compare the two methods to determine the mean line of a surface. **(15)**

(b) With necessary sketches, describe three types of fit the according to the "Hole Based System". Why hole basis system of fit is generally employed? **(10)**

(c) Calculate the overall transfer function for the system shown in the following figure **(10)**