B.E. MECHANICAL ENGINEERING FOURTH YEAR FIRST SEMESTER EXAM 2024

SUBJECT: MATHEMATICAL METHODS IN MECHANICAL ENGINEERING (HONS.)

Time: 3 hours Full Marks: 100

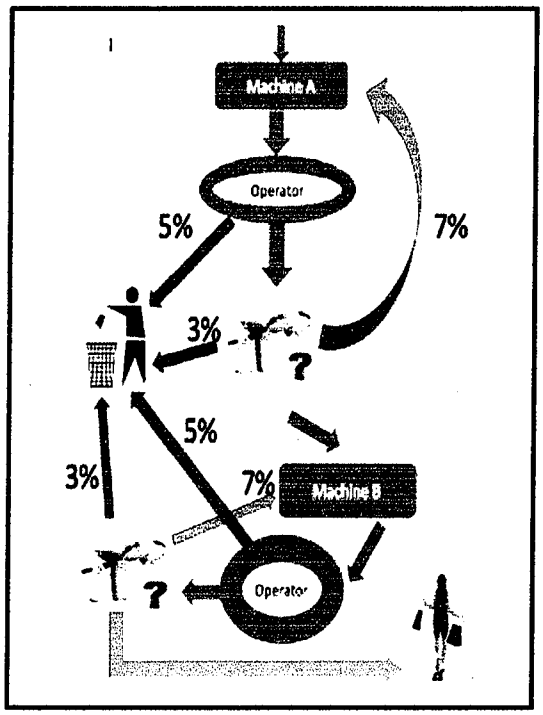
[Use separate answer scripts for PART - I and PART - II]

PART- I (50 Marks)

(Question No. 1 compulsory and answer five from the rest)

1. In a manufacturing industry, raw materials are processed on Machine A and then on Machine B. If the processing is poor on either machine, the operator himself decides to scrap the work-in-progress product or finished product. If the operator okays the product, then the inspector inspects the product at each level critically. This is done after processing the material and/or product on each machine.

Past data shows that 5% of the products are scrapped by the operators on either machine. Past data also shows that after each inspection, 3% of the products are scrapped, 7% of the products are reworked on the respective machines.



Develop the Markov Model with explanation. Show transition probabilities after three iterations (or steps). If one operator process 100 products, how many times, on an average, these are processed on Machine A. [25]

2. Explain the Logit function in relation to logistic regression. [5]
3. Explain Stochastic Process with example. [5]
4. Explain the Chapman-Kolmogorov Equations. [5]
5. State classification of states of Markov Chain. [5]
6. What is machine learning? State objectives of machine learning. [5]
7. Explain IID Noise. [5]
8. The one-step transition probability matrix is given by

$$\begin{pmatrix} 0.8 & 0.2 \\ 0.5 & 0.5 \end{pmatrix}$$

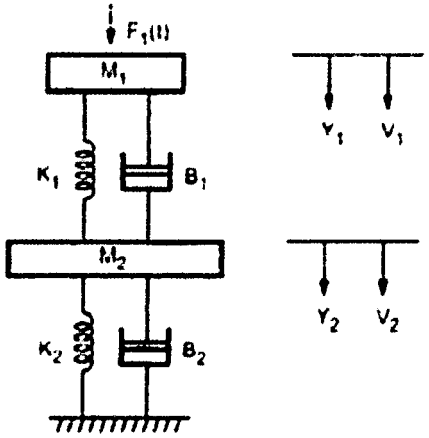
Calculate the desired probability P^4_{00}. [5]

9. Explain R^2 –value with mathematical expression, used in regression. [5]

PART- II (50 Marks)

(Question No. 1 compulsory and answer any three from the rest)

1. Consider the mechanical system shown in the figure. For shown displacements and velocities obtain the state model in standard form. Consider Y_2 to be output. [14]



2. Find the state transition matrix for the equation $X' = AX + BU$, where $A = [1\ 0; 0\ 1]$, $B = [1\ 1]^T$

Also find the time response for the system if $U(t)$ is the unit step occurring at $t = 0$ and $X(0) = [2\ 0]^T$ [12]

3. Find the P.I.s of

a. $(D^2 - D - 2)y = e^{-x} + e^{2x}$

b. $(D^2 - D)y = x^2 + 2x + 4$ [6+6]

4. Using Runge Kutta method solve:

$(y^2 + 2x)dy/dx = (y^2 - x)$ with $y(0) = 1$, for $x = 0.2, 0.3$ [12]

5. Using Runge's method solve:

$(y - 2x^2)dy/dx = (y - x)$ with $y(2) = 5$, for $x = 2.1, 2.4$ [12]