JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2025

MTech-I Semester (Structural Engineering)

COURSE CODE (CREDITS): 25M1WCE131 (3) MAX. MARKS: 35

COURSE NAME: MODELLING, SIMULATION AND COMPUTER APPLICATIONS

COURSE INSTRUCTORS: Dr. Tanmay Gupta MAX. TIME: 2 Hours

Note: *(a) All questions are compulsory.*

(b) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems, Use of scientific calculator is allowed

<table>
<tr><th>Q.No</th><th>Question</th><th>CO</th><th>Marks</th></tr>
<tr><td>Q1</td><td>Following 25 Vehicle headways in seconds were measured on a highway for 100 seconds. Use the Kolmogorov-Smirnov (K-S) goodness-of-fit test to determine if the headways follow an exponential distribution with 5% level of significance.
State the Null and Alternative Hypotheses.
Calculate the K-S test statistic (D).
Given $D_{critical} = 0.272$ for n=25 and alpha=0.05, state your conclusion
1.81, 0.45, 3.12, 0.15, 0.98, 2.50, 0.61, 4.05, 1.44, 0.28, 1.05, 5.10, 0.77, 2.30, 0.55, 1.90, 0.33, 1.62, 2.85, 0.88, 3.50, 0.08, 1.25, 2.15, 0.70</td><td>4</td><td>5</td></tr>
<tr><td>Q2</td><td>A Civil Engineer collects data on the Average Daily Traffic (ADT) and the International Roughness Index (IRI) for eight different road segments as follows:
<table>
<tr><td>IRI</td><td>6.5</td><td>4.3</td><td>6.9</td><td>6.0</td><td>6.9</td><td>5.8</td><td>7.2</td><td>7.8</td></tr>
<tr><td>ADT</td><td>10.3</td><td>8.3</td><td>11.6</td><td>9.7</td><td>11.2</td><td>10.4</td><td>10.9</td><td>12.0</td></tr>
</table>
test whether the two variables, Road Roughness and Traffic Volume are linearly independent or not?</td><td>4</td><td>5</td></tr>
<tr><td>Q3</td><td>The dynamic response of a three-degree-of-freedom structural system can be analyzed by finding the eigenvalues of its dynamic stiffness matrix [D]. Use the Power Method to find the largest eigenvalue its corresponding eigenvector. Also find out remaining two eigen values.
$D = \begin{bmatrix} 1 & 6 & 1 \\ 1 & 2 & 0 \\ 0 & 0 & 3 \end{bmatrix}$</td><td>3</td><td>5</td></tr>
<tr><td>Q4</td><td>The displacement y(t) of a simple structural component subjected to a decaying external force is governed by the following differential equation: $\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + y = e^{-t}$
The system starts from rest, meaning the initial displacement and initial velocity are both zero: $y(0) = y'(0) = 0$
Use the Laplace Transform method to find the time-dependent displacement function, y(t).</td><td>3</td><td>5</td></tr>
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<tr>
<td>Q.5</td>
<td>Nooh's Boats make three different kinds of boats: Rowboat, Canoe, and Kayak. All can be made profitably in this company, but the company's combination of boats that maximize its revenue is constrained by the limited amount of labor, wood, and screws available each month. The director will choose the combination of boats that maximize his revenue in view of the information given in the following table:
<table>
<tr><td>Input</td><td>Row Boat</td><td>Canoe</td><td>Kayak</td><td>Monthly Available</td></tr>
<tr><td>Labor (hours)</td><td>12</td><td>7</td><td>9</td><td>1260 hrs</td></tr>
<tr><td>Wood (Board feet)</td><td>22</td><td>18</td><td>16</td><td>19008 board feet</td></tr>
<tr><td>Screws (Kg)</td><td>2</td><td>4</td><td>3</td><td>396 Kg</td></tr>
<tr><td>Selling Price (Rs)</td><td>4000</td><td>2000</td><td>5000</td><td></td></tr>
</table>
(a) Formulate the above as a linear programming problem.
(b) Solve it by simplex method.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Q.6</td>
<td>Bright Bakery keeps stock of a popular brand of cake. Previous experience indicates the daily demand as given below:
<table>
<tr><td>Daily Demand</td><td>0</td><td>10</td><td>20</td><td>30</td><td>40</td><td>50</td></tr>
<tr><td>Probability</td><td>0.01</td><td>0.20</td><td>0.15</td><td>0.50</td><td>0.12</td><td>0.02</td></tr>
</table>
Generate a sequence of 10 random numbers (R_i) using the Linear Congruential Generator formula: $X_{i+1} = 5X_i + 3 \bmod 100$, Start with a seed value $X_0 = 48$. Use the first 10 values of X_i (starting from X_1) as the random numbers R_i by dividing by 100 ($R_i = X_i/100$).
Using the generated sequence, simulate the demand for the next 10 days. Find out the stock situation (ending inventory/shortage) if the owner of the bakery decides to make 30 cakes every day. Estimate the daily average demand based on the simulated data.</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Q.7</td>
<td>The friction factor (f) for turbulent flow in a pipe network is often approximated using the Colebrook-White equation. For certain flow regimes, this equation can be simplified and rearranged into a non-linear form,as follows to determine a specific flow parameter:
$f(X) = X^3 - 2X - 5 = 0$
Use the Newton-Raphson method to find the root of the equation
Start with an initial guess $X_0 = 2.0$ and perform three iterations to find the approximated root.</td>
<td>1</td>
<td>3</td>
</tr>
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