

Total No. of Questions – [6]

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F. Y. M. TECH. (DESIGN ENGINEERING) (SEMESTER – I)

COURSE NAME: MATHEMATICAL METHODS IN ENGINEERING

COURSE CODE: MEPA11204C

(PATTERN 2020)

Time: [3 Hours]

[Max. marks: 60]

(*) Instructions to candidates:

- 1) All Questions are compulsory
- 2) Figures to the right indicate full marks.
- 3) Use of scientific calculator is allowed
- 4) Use suitable data where ever required

Q.1) A particular type of printer ribbon is produced by only two companies, Alamo Ribbon Company and South Jersey Products. Suppose Alamo produces 65% of the ribbons and that South Jersey produces 35%. Eight percent of the ribbons produced by Alamo are defective and 12% of the South Jersey ribbons are defective. A customer purchases a new ribbon. What is the probability that Alamo produced the ribbon? What is the probability that South Jersey produced the ribbon? The ribbon is tested, and it is defective. Now what is the probability that Alamo produced the ribbon? That South Jersey produced the ribbon?

[10]

Q.2) A specialist in hospital administration stated that the number of FTEs (full-time employees) in a hospital can be estimated by counting the number of beds in the hospital (a common measure of hospital size). A healthcare business researcher decided to develop a regression model in an attempt to predict the number of FTEs of a hospital by the number of beds. She surveyed 12 hospitals and obtained the following data. The data are presented in sequence, according to the number of beds.

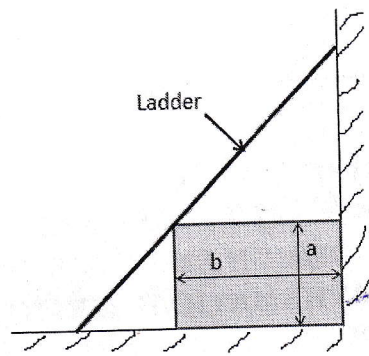
[10]

Number of Beds	FTEs	Number of Beds	FTEs
23	69	50	138
29	95	54	178
29	102	64	156
35	118	66	184
42	126	76	176
46	125	78	225

Compute the sum of squares of error and the standard error of the estimate for Demonstration and develop a regression model to predict the number of FTEs at a hospital by the number of beds.

Q.3) A rectangular box of height 'a' and width 'b' is placed adjacent to a wall as shown in the following Figure. Find the length of the shortest ladder that can be made to lean against the wall.

[10]



Q.4) Find the dimensions of a box of largest volume that can be inscribed in a sphere of unit radius.
[10]

Q.5) A truck company has Rs. 50 lakhs to invest and is to choose among three types of trucks, A, B and C. Truck A has 12-ton payload and is expected to average 50 km per hour. It costs Rs. 80000. Truck B has 20-ton payload, is expected to average 45 km/hr and costs Rs. 100000. Truck c is a modified form of truck B. It has slipping space for the driver, which reduces its payload capacity to 17 ton, while raising the cost to Rs. 120000. Truck requires a crew of one man, and if driven on three shifts per day, could run for an average of 20 hours a day. Trucks B and C require a crew of two men each and if driven on three shifts per day, could be run for 19 hours and 22 hours respectively. The company has a fleet of 120 crewmen available to it. If the total numbers of trucks are not to exceed 40, how many trucks of each type should be purchased if the company wants to maximize its capacity in ton-km per day? Formulate the L.P. problem.
[10]

Q.6) Solve the one-dimensional wave equation
[10]

$$\frac{\partial^2 u}{\partial x^2} = \frac{1}{16} \frac{\partial^2 u}{\partial t^2} \quad \text{for } 0 < x < 2, \quad t > 0$$

The boundary conditions are

$$u(0, t) = u(2, t) = 0$$

The initial conditions are

$$(i) \quad u(x, 0) = 6 \sin \pi x - 3 \sin 4\pi x \quad (ii) \quad \frac{\partial u}{\partial t}(x, 0) = 0$$