

[3 Hours]

[Total Marks: 80]

- N.B (1) Question No. 1 is compulsory.
 (2) Attempt any **three** of the remaining.
 (3) Use of statistical table is allowed.

1. (a) Using Green's theorem evaluate. 5

$\int_C \vec{F} \cdot d\vec{r}$ where $\vec{F} = x^2\hat{i} - xy\hat{j}$ and c is the triangle having vertices $A(0,2)$, $B(2,0)$, $C(4,2)$

- (b) Use Cayley – Hamilton theorem to find $2A^4 - 5A^3 - 7A + 6I$ where $A = \begin{bmatrix} 1 & 2 \\ 2 & 2 \end{bmatrix}$ 5

- (c) If the mean of the following distribution is 16 find m, n and variance 5

X	8	12	16	20	24
P (X=x)	1/8	m	n	1/4	1/12

- (d) The average of marks scored by 32 boys is 72 with standard deviation 8 while that of 36 Girls is 70 with standard deviation 6. Test at 1% level of significance whether the boys perform better than girls. 5

2. (a) Calculate Spearman's coefficient of rank correlation from the data on height and weight of 8 students 6

Height (in inches)	60	62	64	66	68	70	72	74
Weight (in lbs)	92	83	101	110	128	119	137	146

- (b) It is known that the probability of an item produced by a certain machine will be defective is 0.05. If the produced items are sent to the market in packets of 20, find the number of packets containing (i) at least 2 (ii) exactly 2 (iii) at most 2 defective items in a consignment of 1000 packets using Poisson distribution. 6

- (c) Find the eigen values and eigen vectors of the matrix 8

$$A = \begin{bmatrix} 8 & -8 & -2 \\ 4 & -3 & -2 \\ 3 & -4 & 1 \end{bmatrix}$$

[Turnover

3. (a) Two different processes A and B are used to manufacture light bulbs. Samples were drawn from these two populations and following results were obtained

Population	A	B
Sample size	20	17
Sample Standard deviation	60	50

Test the hypothesis that variance of A is greater than variance of B

- (b) Using the method of Lagrange's multipliers solve the following N.L.P.P. 6

Optimize $Z = 6x_1^2 + 5x_2^2$

Subject to $x_1 + 5x_2 = 7$ and $x_1, x_2 \geq 0$

- (c) Prove that $\vec{F} = (2xy + z)\hat{i} + (x^2 + 2yz^3)\hat{j} + (3y^2z^2 + x)\hat{k}$ is irrotational. Find the 8

scalar potential for \vec{F} and the work done in moving an object in this field from

(1, 2, 0) to (2, 2, 1)

4. (a) In an intelligence test administered to 1000 students the average score was 42 and 6

standard deviation was 24. Find the number of students (i) exceeding the score 50

(ii) between 30 and 54

- (b) Use Gauss's divergence theorem to evaluate $\iiint_S \vec{N} \cdot \vec{F} ds$ where $\vec{F} = 2x\hat{i} + xy\hat{j} + z\hat{k}$ 6

over the region bounded by the cylinder $x^2 + y^2 = 4$, $z = 0$, $z = 6$

- (c) A sample of 400 students of undergraduates and 400 students of post graduate 8

Classes was taken to know their opinion about autonomous colleges. 290 of the

undergraduate and 310 of the post graduate students favored the autonomous status.

Present these facts in the form of a table and test at 5% level, that the opinion regarding

Autonomous status of colleges is independent of the level of classes of students

5. (a) Seven dice are thrown 729 times. How many times do you expect at least four dice 6

to show three or five?

- (b) Use Stoke's theorem to evaluate $\int_C \vec{F} \cdot d\vec{r}$ where $\vec{F} = 4xzi\hat{i} - y^2\hat{j} + yz\hat{k}$ and c is 6

the boundary of $x=0$, $y=0$ and $x^2 + y^2 = 1$ in the plane $z = 0$

[Turnover

- (c) A chemical engineer is investigating the effect of process operating temperature X on product yield Y . The results in the following data 8

X	100	110	120	130	140	150	160	170	180	190
Y	45	51	54	61	66	70	74	78	85	89

Find the equation of regression line which will be able to predict yield on the basis of Temperature. Find also the correlation coefficient between X and Y

6. (a) Ten individuals are chosen at random from a population and their heights are found to be 63, 63, 64, 65, 66, 69, 69, 70, 71, 70 inches. Discuss the suggestion that the mean height of the population is 65 inches. 6

- (b) Show that the matrix A is derogatory and find its minimal polynomial 6

$$A = \begin{bmatrix} 2 & -3 & 3 \\ 0 & 3 & -1 \\ 0 & -1 & 3 \end{bmatrix}$$

- (c) Using the Kuhn-Tucker conditions solve the following problem 8

$$\text{Maximize } z = 10x_1 + 10x_2 - x_1^2 - x_2^2$$

$$\text{Subject to } x_1 + x_2 \leq 8$$

$$-x_1 + x_2 \leq 5$$

$$x_1, x_2 \geq 0$$

(3 Hours)

[Total Marks: 80

- N.B. (1) Question No. 1 is compulsory
(2) Attempt any **three** questions out of the remaining **five** questions.
(3) Figures to the **right** indicate **full marks**.
(4) Assume suitable data wherever required but justify the same.

1. Write short note on any 4 of the following

[20]

- Mobility of Mechanisms
 - Law of belting and slip in belt
 - Types of follower
 - Mechanisms used in 3D printer
 - Compliant mechanisms
2. (a) A cord is wrapped on a 2 m diameter disc, which weighs 250 N. if the cord is pulled upwards with a force of 400 N, determine the acceleration of the centre of the disc, the angular acceleration of the disc, and the acceleration of the cord. [6]

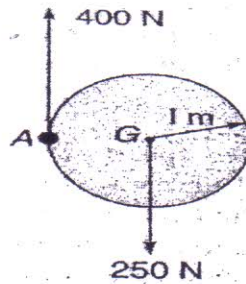


Figure 1

- (b) Fig. 2 shows the mechanism of a sewing machine needle box. For the given configuration, find the velocity of the needle fixed to the slider D when the crank OA rotates at 40 rad/s. [8]

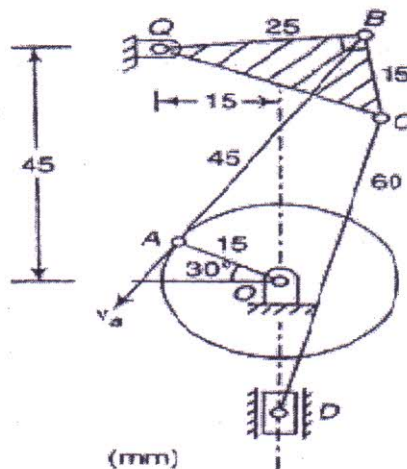


Figure. 2

- (c) Explain four bar chain and its anyone inversion.

[6]

Turn Over

3. (a). In the mechanism shown in figure 3, the crank OA rotates at 210 rpm counter-clockwise [14]
for the given configuration, determine
(i) velocity of slider D and the angular velocity of link CD
(ii) acceleration of slider D and the angular acceleration of link CD

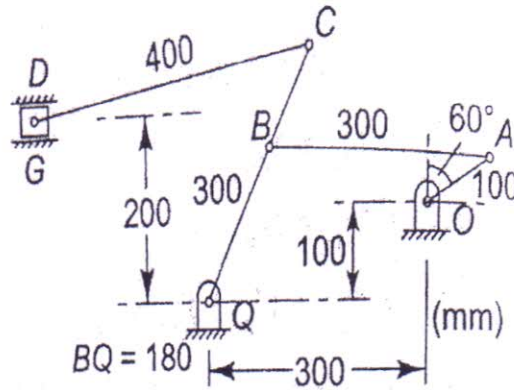


Figure 3

- (b) How can you ensure that a Paucellier mechanism traces an exact straight line. [6]
- 4 (a) Design a slider-crank mechanism to coordinate three positions of the input and of the slider for the following data by inversion method: [12]
- | | |
|--------------------------|--------------------------|
| $\theta_{12} = 30^\circ$ | $S_{12} = 40 \text{ mm}$ |
| $\theta_{13} = 60^\circ$ | $S_{13} = 96 \text{ mm}$ |
- Eccentricity = 20 mm
- (b) Two 20° involute spur gears mesh externally and give a velocity ratio of 3. The module is 3 mm and the addendum is equal to 1.1 module. If the pinion rotates at 120 rpm., determine the [8]
(i) minimum number of teeth on each wheel to avoid interference
(ii) contact ratio
- 5 (a) In an open-belt drive, the diameters of the larger and the smaller pulleys are 1.2 m and 0.8 [10]
respectively. The smaller pulley rotates at 320 rpm. The centre distance between the shafts is 4 m.
when stationary, the initial tension in the belt is 2.8 kN. The mass of the belt is 1.8 kg/m and the
coefficient of friction between the belt and the pulley is 0.25. determine the power transmitted.
(b) Explain the term: function generation, path generation and motion generation. [6]
(c) Make a comparison of cycloidal and involute tooth forms [4]
- 6 (a) Draw the profile of a cam operating a knife edge follower having a lift of 30mm. The cam raises [14]
the follower with SHM for 150° of the rotation followed by a period of dwell for 60° . The follower
descends for the next 100° rotation of the cam with uniform velocity, again followed by a dwell
period. The cam rotates at uniform velocity of 150 rpm and has a least radius of 30mm.
What will be the maximum velocity and acceleration of the follower during lift and return?
(b) What do you mean by dimensional synthesis of a pre-conceived type mechanism [6]

