Time: 3 hrs **Total Marks: 80**

Note:

1. **Question No. 1 is compulsory.**
2. **Attempt any three from the reaming five questions.**
3. **Assume suitable data wherever required with proper justification.**

Q1 Attempt any four of the following. All sub-question carries equal marks

A	Differentiate between Porter and Hartnell governor.	5
B	Derive the relation for Gyroscopic couple during pitching of ship and discuss its effect.	5
C	Discuss different types of damping.	5
D	Explain dynamically equivalent system with correction couple.	5
E	Plot variation between frequency ratio vs magnification factor and conclude graph.	5

Q2

2A. Find the natural frequency of a half solid cylinder of mass m and radius r when it is slightly displaced from the equilibrium position and released. 10

2B A Porter governor has rotating mass of each ball 5 kg and mass on the sleeve is 30 kg. Upper links are 250 mm long and lower links are 350 mm long.The upper ends of upper links and lower ends of lower links are hinged at 40 mm from the governor axis. Find equilibrium speed of the governor in rpm when the governor rotates at 130 mm radius. 10

Q3

3A. The turbine rotor of a ship has a mass of 2000 kg and it rotates at a speed of 3000 rpm clockwise when seen from stern .The radius of gyration of the rotor is 0.5 m . 10
1.Determine the gyroscopic couple and its effect, if the ship is steering to the right in a curve of 100 m radius at a speed of 16.1 knots. Assume 1 knot = 1855 m/hr.
2.Calculate the gyroscopic couple and its effect when the ship is pitching in SHM, with the bow falling with its maximum velocity. The period of pitching is 50 sec and the total angular displacement between the two extreme positions is 12^0. Find maximum acceleration during the pitching motion.

3B. An underdamped shock absorber is to be designed for a motorcycle of mass 200 kg, such that during a road bump, the damped period of vibration is limited to 2 sec and the amplitude of vibration shoud reduce to one-sixteen in one cycle. 10
Find spring stiffness and damping coefficient of the shock absorber.

Q4.

4A. In a vertical double acting steam engine ,the connecting rod is 4.5 times the crank .The mass of reciprocating parts is 120 kg and the stroke of the piston is 440 mm.The engine runs at 250 rpm.If the net load on the piston due to steam pressure is 25 KN when the crank has turned through an angle of 120^0 from the TDC , Determine 10

1.thrust in connecting rod 2.thrust on cylinder 3.tangential force on crank pin

4.thrust on bearing 5.turning moment on crankshaft

4B. A 30 Kg block is connected to a spring of stiffness 1.5×10^5 N/m. The coefficient of friction between block and surface on which its slides is 0.15. The block is displaced 12 mm from equilibrium and released. Calculate amplitude of motion at the end of the first cycle. How many cycles of motion occur? 10

Q5.

5A. If the peak amplitude of a single degree of freedom system under harmonic excitation is observed to be 0.6 cm. If the undamped natural frequency of the system is 6 Hz. And the static defection of the mass under the maximum force is 0.3 cm, estimate the damping ratio of the system and peak frequency. 12

5B.A seismic instrument with natural frequency of 7 Hz is used to measure vibration of machine running at 100 rpm. The instrument gives reading for relative displacement of mass as 0.07mm. Determine amplitude of displacement, velocity and acceleration of vibrating machine, by Neglecting damping. 08

Q6.

6A. The four masses m1, m2, m3 and m4 having their radii of rotation as 250 mm, 150 mm, 200 mm and 350 mm are 250 kg, 350 kg, 240 kg and 200 kg in magnitude respectively. The angles between the successive masses are 40-degree, 70 degree and 130 degree respectively. Find the position and magnitude of the balance mass required, if its radius of rotation is 150 mm. 08

6B. i) Write short note on partial balancing in reciprocating masses. 07

ii) Discuss fault diagnosis. 05

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Time: 3 Hours **Total Marks:80**

Note:

1) Question No. 1 is compulsory.
2) Answer any three out of the remaining five questions.
3) Figures to the right indicate full marks.
4) Illustrate answers with neat sketches wherever required.

Q1 Solve any four

a) How optimization problems can be classified (5)

b) Write the dual of the following primal LP problems (5)
Max $Z = 2x_1 + 5x_2 + 6x_3$
subject to (i) $5x_1 + 6x_2 - x_3 \leq 3$ (ii) $-2x_1 + 3x_2 + 4x_3 \leq 4$
(iii) $x_1 - 5x_2 + 3x_3 \leq 1$ (iv) $-3x_1 - 3x_2 + 7x_3 \leq 6$ and $x_1, x_2, x_3 \geq 0$

c) Illustrate difference in linear and nonlinear optimization problem with suitable example. (5)

d) State methods of normalization and explain any one. (5)

e) Explain Taguchi's loss function (5)

Q2 a) Solve the following problem by simplex method (10)
Maximize $Z = 30x_1 + 20x_2$
Subject to $x_1 + x_2 <= 40$
$x_1 - x_2 <= 20$
$x_1, x_2 >= 0$

b) A company manufactures around 200 bikes. Depending upon the availability of raw materials and other conditions, the daily production has been varying from 196 to 204 bikes , whose probability distribution is as given below: (10)

Production/day	196	197	198	199	200	201	202	203	204
Probability	0.05	0.09	0.12	0.14	0.20	0.15	0.11	0.08	0.06

The finished bikes are transported in a specially designed three-storied lorry that can accommodate only 200 mopeds. Using the following 10 random numbers: 82, 89, 78, 24, 53, 61, 18, 45, 23, and 50, simulate production for 10 days
(a) What will be the average number of bikes made in 10 days?
(b) What will average number of bikes waiting in company to be transported in 10 days

Q3 a) Using the Lagrange's multiplier method solve the following NLPP (10)
Optimize $Z = 4x_1^2 + 2x_2^2 + x_3^2 - 4x_1x_2$
S.T. $x_1 + x_2 + x_3 = 15$
$x_1, x_2, x_3 \geq 0$

b) A company sells two different products A and B, making a profit of Rs 40 and Rs 30 per unit, respectively. They are both produced with the help of a common production process and are sold in two different markets. The production process has a total capacity of 30,000 man-hours. It takes three hours to produce a unit of A and one hour to produce a unit of B. The market has been surveyed and company officials feel that the maximum number of units of A that can be sold is 8,000 units and that of B is 12,000 units. Subject to these limitations, products can be sold in any combination. Formulate this problem as an LP model to maximize profit. (5)

c) State various Linear programming methods and state its suitability with illustration (5)

Q4 a) What are the various non-traditional optimisation techniques? Explain any one with illustration. (10)

b) Discuss in brief some applications of Optimization in Engineering (5)

c) A manufacturing firm produces two types of products: A and B. The unit profit from product A is Rs 200 and that of product B is Rs 150. The goal of the firm is to earn a total profit of exactly Rs 900 in the next week. The demand of A and B are upto maximum 30 and 40 quantities respectively. Formulate as a goal programming model. (5)

Q5 a) Following table shows the various alternatives of Material (M1, M2,..) for piston cyinder, and corresponding attributes as Cost (A1), tensile strength (A2), thermal conductivity (A3), and machinability index (A4) Suggest suitable material using SAW method. Assume equal weight of 0.25 for the all attributes, A1 as non-beneficial and rest all as beneficial attributes for the following case. (10)

No	Alternative	M1(Rs/kg)	A2 (MPa)	A3 (W/m-K)	A4
1	M1	300	110	142	100
2	M2	350	100	125	110
3	M3	375	120	100	105
4	M4	400	130	120	120
5	M5	315	125	135	115

b) Find the maxima and minima, if any, of the function $f(x) = 4x^3 - 18x^2 + 27x - 7$ (5)

c) Explain concept of Dynamic programming (5)

Q6 a) Explain design of experiments. Explain its application and state its importance. (10)

b) What we mean by full factorial and fractional factorial experiments. (5)

c) Explain concept of robust design (5)