

(3 Hours)

Total Marks: 80

N.B. : (1) Question No. 1 is compulsory.

(2) Attempt any three questions out of remaining five questions

Q.1. (a) By using matrices, Solve the following system of linear equation (5)

$$x+y+z=9, \quad 2x+5y+7z=52, \quad 2x+y-z=0.$$

(b) Differentiate between Simple Random Sampling and Stratified Random Sampling (5)

(c) Explain Scatter plots. (5)

(d) Compare constrained and non constrained optimization Techniques (5)

Q.2. (a) Find Singular Value of Decomposition of matrix $A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \\ -1 & 1 \end{bmatrix}$ (10)

(b) A company gave an intensive training to its salesmen to increase the sales. A random sample of 10 salesmen was selected and the value (in lakhs of Rupees) of their sales per month, made before and after the training is recorded in the following table. (10)

Salesman	1	2	3	4	5	6	7	8	9	10
Before	15	22	6	17	12	20	18	14	10	16
After	17	23	16	20	14	21	18	20	10	11

Test whether there is any increase in mean sales at 5% level of significance.

Table Values: $t(\alpha, df, \text{test type})$

$$t(0.05, 10, \text{one-tailed}) = 1.812$$

$$t(0.05, 9, \text{one-tailed}) = 1.833$$

$$t(0.05, 10, \text{two-tailed}) = 2.228$$

$$t(0.05, 9, \text{two-tailed}) = 2.262$$

Q.3. (a) A survey was conducted with 500 female students of which 60% were intelligent, 40% had uneducated fathers, while 30% of the not intelligent female students had educated fathers. Test the hypothesis that the education of fathers and intelligence of female students are independent at 5% level of significance. (Given $\chi^2(1, 0.05) = 3.841$) (10)

(b) What is a Graph? Explain any four types of Graph along with its uses. (10)

Q.4. (a) Explain types of data. Compare and contrast quantitative and qualitative data. (10)

(b) Discuss the need for exploratory data analysis and explain types of Exploratory data analysis. (10)

Q.5. (a) Minimize the function $f(x_1, x_2) = 4x_1 + 8x_2 - x_1^2 - x_2^2$ (10)
subject to $x_1 + x_2 = 4, \quad x_1, x_2 \geq 0$

(b) Find the minimizer of $f(x) = x^2 + \frac{54}{x}$ using bisection method in (2,5) within a range of 0.3 (10)

- Q.6. Write short notes on (any four) **(20)**
- (a) Four Fundamental Subspaces **(5)**
 - (b) Principal Component Analysis (PCA) algorithm. **(5)**
 - (c) Benefits of Dimensionality Reduction. **(5)**
 - (d) 5 Number Summary (the box and whisker plot.) **(5)**
 - (e) Gradient based optimization Techniques **(5)**
 - (f) Exponential function and their graph. **(5)**
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(3 Hours)

[Marks: 80]

- N.B.: 1) Question No. 1 is compulsory.
2) Answer any three out of the remaining questions.
3) Assume suitable data if necessary.
4) Figures to the right indicate full marks.

	Marks
Q1. Attempt any four.	20
a. Explain Simplified Payment Verification (SPV) and write down its key features.	
b. What is mining and what is need of Mining in Blockchain?	
c. Explain how Bitcoin Transaction works.	
d. Explain Public Key and Private key in bitcoin wallet with its generation process.	
e. Explain peer to peer network architecture in Blockchain.	
Q2 a. Explain Merkle trees also explain what is importance of Merkle in Blockchain?	10
b. What is decentralized consensus? Explain Byzantine General's Problem in detail.	10
Q3 a. What is need of fork in Blockchain; differentiate between soft fork and hard fork.	10
b. Explain different types of wallets along with their merits and demerits; also explain factors which decide which type of wallets are used for any particular application.	10
Q4 a. Explain Pay to public key hash (P2PKH) transaction in detail with example.	10
b. Which cryptographic algorithm is used in Blockchain explain with example.	10
Q5 a. What is a node in Blockchain network? List and explain various types node in Blockchain.	10
b. Explain SVP nodes and privacy in detail.	10
Q6 Write short note on any four.	20
a. Assembling and selecting chain of blocks.	
b. Bitcoin relay network	
c. Blockchain Technology in Supply chain & logistics	
d. Blockchain Technology in Energy	
e. Bitcoin Transaction	

(3 Hours)

Total Marks: 80

Note:

1. Question No. 1 is compulsory.
2. Attempt any **THREE** out of the remaining **FIVE** questions.
3. Assume suitable data if necessary.

- Q.1** Solve any Four out of Five 20
- A Define the Alternate Hypothesis in DOE.
- B Define the Null Hypothesis in DOE.
- C Write Guidelines for Designing Experiments
- D Define the Population in DOE.
- E What is replication? Why do we need replication in an experiment?
- Q.2** A List Guidelines for Designing Experiments and explain any one 10
- B Table presents the effective life (in hours) observed in the battery design example. 10
Do the Analysis of Variance for Battery Life Data and find Sum of Square, Degrees of Freedom, and fill it in table given.

Material type	Temperature ($^{\circ}$ F)					
	15		70		125	
1	130	155	34	40	20	70
	74	180	80	75	82	58
2	150	188	136	122	25	70
	159	126	106	115	58	45
3	138	110	174	120	96	104
	168	160	150	139	82	60

The Analysis of Variance Table for the Two-Factor Factorial, Fixed Effects Model

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F_0
A treatment				
B treatment				
Interaction				
Error				
Total				

- Q.3** A Write basic definitions and principles of factorial design 10
- B Explain with example "The Two-Factor Factorial Design" 10

- Q.4** A Write Features of a desirable design while selecting the response surface design. 10
 B The tensile strength of a paper product is related to the amount of hardwood in the pulp. Ten samples are produced in the pilot plant, and the data obtained are shown in the following table. 10

strength	Precent hard wood	strength	Precent hard wood
160	10	181	20
171	15	188	25
175	15	193	25
182	20	195	28
184	20	200	30

Find

1. Mean square value of block in this experiment
2. Degree of freedom the block in this experiment
3. Mean square value of treatment in this experiment
4. Degree of freedom the treatment in this experiment

Mean square value of residual in this experiment

- Q.5** A Explain in detail Basic Principles of Randomization 10
 B What are the potential risks of a single large, comprehensive experiment in contrast to a sequential approach? 10

- Q.6** **Write** 20
 A Define the Sample in DOE.
 B Define the Degrees of Freedom in DOE
 C When to use Design of Experiments?
 D Write a note on Latin Square Design with example.
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3 Hours

Total Marks: 80

Note:

1. Question No. 1 is compulsory.
2. Attempt any three from the remaining 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** Explain the effect of Gyroscopic couple on a naval ship during steering, pitching and rolling. 5
- C** A connecting rod of mass $m = 3 \times 10^{-3}$ kg and $I = 0.432 \times 10^{-4}$ kgm^2 is suspended on a knife edge about the upper inner surface of a wrist-pin bearing, When disturbed slightly, the rod was observed to oscillate harmonically with $\omega_n = 6$ rad/s. Determine the distance between the support and the C.G. 5
- D** Define (a) Critical damping coefficient (b) Damping factor (c) Logarithmic Decrement (d) Significance of logarithmic decrement (e) Viscous Damping 5
- E** Explain Correction Couple in dynamically equivalent system. 5
- F** Plot variation between frequency ratio vs phase angle. 5
- Q2**
- 2A.** Calculate natural frequency of simple pendulum by using Energy method. 08
- 2B.** The arms of a Porter governor are each 250 mm long and pivoted on the governor axis. The mass of each ball is 5 kg and the mass of the central sleeve is 30 kg. The radius of rotation of the balls is 150 mm when the sleeve begins to rise and reaches a value of 200 mm for maximum speed. Determine the speed range of the governor. If the friction at the sleeve is equivalent of 20 N of load at the sleeve, determine how the speed range is modified. 12
- Q3**
- 3A.** The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship: 10
1. when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h.
 2. when the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees.
- 3B.** A mass of 2 kg is to be supported on a spring having a stiffness of 10000 N/m. The damping coefficient is 5 N.sec/m. Determine the natural frequency of the system. Also find Logarithmic decrement & the amplitude after three cycles if the initial displacement is 0.35 cm. 10

Q4.

4A. A vertical double acting steam engine has a cylinder 300 mm diameter and 450 mm stroke and runs at 200 r.p.m. The reciprocating parts has a mass of 225 kg and the piston rod is 50 mm diameter. The connecting rod is 1.2 m long. When the crank has turned through 125° from the top dead centre, the steam pressure above the piston is 30 kN/m^2 and below the piston is 1.5 kN/m^2 . Calculate the effective turning moment on the crank shaft. 10

4B. A 35 Kg block is connected to a spring of stiffness $1.7 \times 10^5 \text{ N/m}$. The coefficient of friction between block and surface on which its slides is 0.10. The block is displaced 10mm from equilibrium and released. Calculate amplitude of motion at the end of the first cycle. How many cycles of motion occur? 10

Q5.

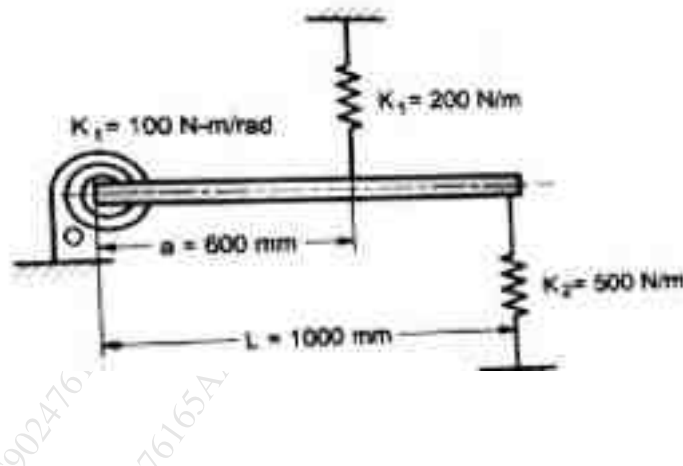
5A. If the peak amplitude of a single degree of freedom system under harmonic excitation is observed to be 0.5cm. If the undamped natural frequency of the system is 5Hz . And the static deflection of the mass under the maximum force is 0.25cm, estimate the damping ratio of the system and peak frequency. 12

5B. A seismic instrument with natural frequency of 6Hz is used to measure vibration of machine running at 120 rpm. The instrument gives reading for relative displacement of mass as 0.05mm. Determine amplitude of displacement, velocity and acceleration of vibrating machine, by Neglecting damping. 08

Q6.

6A. The four masses m_1, m_2, m_3 and m_4 having their radii of rotation as 200 mm, 150 mm, 250 mm and 300 mm are 200 kg, 300 kg, 240 kg and 260 kg in magnitude respectively. The angles between the successive masses are 45 degree, 75 degree and 135 degree respectively. Find the position and magnitude of the balance mass required, if its radius of rotation is 200mm 08

6B. Determine the natural frequency of vibration for a system in Fig. Take mass of the beam as 5 kg. 12



- N.B:** 1) Question No. 1 is **compulsory**.
 2) Attempt any **THREE** questions out of remaining **FIVE** questions
 3) Assume suitable data wherever necessary.
 4) Use of Graph paper is allowed.
 5) Figures to the right indicate full marks

1. Answer the following questions.

20

- i) Distinguish between Line, End and Wavelength Standard.
- ii) Distinguish between open loop and closed loop control system with suitable examples.
- iii) Explain working LVDT with neat sketch.
- iv) While measuring the speed of steam turbine with stroboscope, stationary image was observed for three consecutive stroboscope settings of 3000, 4000 and 5250 flashes per minute. Calculate the rotational speed of turbine.

2. (A) Reduce the following block diagram and find the transfer function.

10

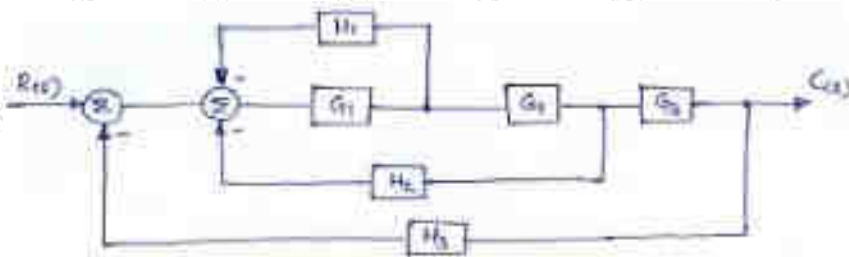


Fig.1

- (B) What is Taylors principle, explains in detail? Write note on Hole Basis System and Shaft Basis System.

10

3. (A) For a particular unity feedback system

10

$$G(s) = \frac{10}{S(S + 1)(S + 5)}$$

Sketch the Bode Plot, Find ω_{gc} , ω_{pc} , GM and PM. Comment on stability.

- (B) b) A unity feedback system characterized by an open loop transfer function

10

$$G(s) = \frac{K}{S(S + 2)(S^2 + 4S + 5)}$$

Determine the gain K. so that the system will be stable.

4. (A) Explain principle of interference. How flatness can be checked with help of optical interferometer. **10**

(B) What are desired, Modifying, Interfering input? Explain with example of each. Also suggest method to minimize the effect of Modifying & Interfering inputs. **10**

5. (A) Draw the Root-Locus of the system having **10**

$$G(s)H(s) = \frac{K}{s(s+5)(s+10)}$$

(B) Draw neat labelled diagram of Taylor Hobson Talysurf and briefly explain working principle. State one major advantage and disadvantage of this instrument over Tomlinson surface meter. **10**

6. (A) What are the different elastic transducers used for pressure measurement? Illustrate working principle of any one transducer in detail. **10**

(B) Write short note on (any Two) **10**

- i) Parkinson's gear tester
- ii) Two wire method
- iii) Optical encoder

Time: 3 Hrs

Marks : 80

- 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.

- Q. 1** Explain briefly any four **20**
- a Robust design
 - b Engineering applications of optimization
 - c Integer Programming
 - d Genetic Algorithm
 - e Analytic Hierarchy Process (AHP) Method
- Q2** a Explain design of experiments. Explain its application and state its importance. **10**
- b A firm manufacture product P & Q which pass through machining and finishing departments. Machining has 90 hours available; finishing can handle up to 72 hours of work. Manufacturing one product P requires 6 hours in machining and 3 hours in finishing. Each product Q requires 3 hours in machining and 6 hours in finishing. If profit is Rs. 120/- per product P and Rs. 90/- per product Q. Formulate as goal programming problem to determine combination of product P & Q to realise profit of exactly Rs. 2100 **10**
- Q3** a Find the maximum and minimum value of $y = 3x^5 - 5x^3$. **10**
- b Solve LPP by simplex method **10**
Maximize: $Z = 40x_1 + 35x_2$ subjected to,
 $2x_1 + 3x_2 \leq 60$
 $4x_1 + 3x_2 \leq 96$
 $x_1, x_2 \geq 0$

Q4 a Solve following problem by big M method **10**
 Minimize $Z = 600x_1 + 500x_2$ subjected to,
 $2x_1 + x_2 \geq 80$
 $x_1 + 2x_2 \geq 60$, where $x_1, x_2 \geq 0$.

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 State methods of normalization and explain any one. **5**

Q5 a Solve the following NLPP: Maximum $Z = 4x_1 + 6x_2 - 2x_1x_2 - 2x_2^2$ **10**
 subjected to $x_1 + 2x_2 = 2$, $x_1, x_2 \geq 0$.

b Explain concept of dynamic programming and bellman's principle of optimality **10**

Q6 a Explain multi attribute decision making with suitable illustration **10**

b Explain briefly taguchi's loss function **5**

c A production process makes batteries for 9 +/- 0.25 volts applications at a cost of \$ 0.75 each. Determine: **5**

a. Complete expression for loss function

b. Loss when a part is made at 9.10 V

- Note: 1. Assume suitable data if necessary
 2. Figures to the right indicate full marks
 3. Question No. 1 is compulsory
 4. Solve any **three** out of the remaining **five** questions

Q1. Solve any four

- A Derive an expression for the critical radius of insulation for the sphere. **5**
 B State Fourier and Biot numbers? Also explain the significance of these numbers. **5**
 C Draw a boiling curve and identify the different boiling regimes. Explain each regime in brief. **5**
 D State and explain Fick's Law of diffusion. **5**
 E Explain the valve timing diagram for four-stroke SI engines. **5**
 F Explain EURO and BHARAT norms. **5**

Q2.

- A A Cylindrical tank of 1.0 m diameter and 5 m total length has hemispherical ends. It contains liquid oxygen, which has a boiling point and heat of vaporization of -180°C and 210 kJ/kg , respectively. It is required to insulate the tank so as to reduce the boil-off rate of oxygen in a steady state to 14 kg/h . Determine the thermal conductivity of the insulating material if its maximum thickness is limited to 70 mm . Assume room temperature outside the insulation as 25°C . **10**

- B During the trial of a single-cylinder, four-stroke oil engine, the following results were obtained. **10**

Cylinder diameter	20 cm.
Stroke	40 cm
Mean effective pressure	6 bar
Torque	407 Nm
Speed	250 rpm
Oil consumption	4 kg/h
Calorific value of fuel	43 MJ/kg
Cooling water flow rate	4.5 kg/min
Air used per kg of fuel	30 kg
Rise in cooling water temperature	45°C
Temperature of exhaust gases	420°C
Room Temperature	20°C
Mean specific heat of exhaust gas	1kJ/kg K
Specific heat of water	4.18 kJ/kg K

Find the IP, BP and draw up a heat balance sheet for the test in kJ/h .

Q3.

- A Discuss the electrical analogy of combined heat conduction and convection in two-layer composite wall. **5**
 B A steel ball 50 mm in diameter and at 900°C is placed in a still atmosphere of 30°C . Calculate the initial rate of cooling of the ball in $^{\circ}\text{C}$ per min. **5**
 C Explain with neat sketch stages of combustion of the CI engine. **10**

Q4.

- A A steel rod ($k = 32 \text{ W/m}^\circ\text{C}$), 12 mm in diameter and 60 mm long, with an insulated end, is to be used as a spine. It is exposed to surroundings with a temperature of 60°C and a heat transfer coefficient of $55 \text{ W/m}^2\text{C}$. The temperature at the base of fin is 95°C . Determine: **10**
- (i) The fin efficiency.
 - (ii) The temperature at the edge of the spine.
 - (iii) The heat dissipation.
- B State and explain kirchoff's law. **5**
- C With suitable example/ values prove that during the load test of an engine, increases in the load increases the mechanical efficiency of the engine. **5**

Q5.

- A A counter-flow double pipe heat exchanger using superheated steam is used to heat water at the rate of 10500 kg/h. The steam enters the heat exchanger at 180°C and leaves at 130°C . The inlet and exit temperatures of water are 30°C and 80°C , respectively. If the overall heat transfer coefficient from steam to water is $814 \text{ W/m}^2\text{C}$, calculate the heat transfer area. What would be the increase in the area if the fluid flows were parallel? **10**
- B A 4-stroke motorcycle petrol engine cylinder consists of 15 hollow fins. If the outside and inside diameters of each fin are 200 mm and 100 mm, respectively, the average fin surface temperature is 475°C , and the atmospheric air temperature is 25°C , calculate the heat transfer rate from the fins When the motor cycle is running at a speed of 60 km/h. The fin may be idealised as a single horizontal flat plate of the same area. **10**
- Assume characteristic length is 0.9 times the outside diameter.
- $$\overline{Nu} = 0.036(Re)^{0.8} (Pr)^{0.33}$$
- $$\overline{Nu} = 0.54(Gr.Pr)^{0.25}$$
- The thermophysical properties of air at 250°C are
 $k = 4.266 \times 10^{-2} \text{ W/m }^\circ\text{C}$, $\nu = 40.61 \times 10^{-6} \text{ m}^2/\text{s}$, $Pr = 0.677$

Q 6.

- A Explain with a neat sketch working of the battery ignition system. **5**
- B Explain the Fouling of Heat Exchangers. **5**
- C Calculate the heat transfer from a 60W incandescent bulb at 115°C to ambient air at 25°C . Assume the bulb is a sphere of 50 mm in diameter. Also, find the percentage of power lost by free convection. **5**
- The correlation is given by: $Nu = 0.60 (Gr.Pr)^{1/4}$
 The thermophysical properties of air at 70°C are
 $k = 2.964 \times 10^{-2} \text{ W/m }^\circ\text{C}$, $\nu = 20.02 \times 10^{-6} \text{ m}^2/\text{s}$ $Pr = 0.694$
- D Write down the general heat conduction equation in cartesian coordinates. State the assumptions and get the Fourier, Poisson's and Laplace equations from it. **5**