Seat Number

* 2 6 1 8 *

ELECTIVE – II
Machine Tool Design
(1100 / 1102)

P. Pages : 2

Time : Three Hours **Max. Marks : 100**

Instructions to Candidates :

1. Do not write anything on question paper except Seat No.
2. Answer sheet should be written with black ink only. Graph or diagram should be drawn with the same pen being used for writing paper or black HB pencil.
3. Students should note, no supplement will be provided.
4. Answer **any five** questions.
5. Neat diagrams must be drawn wherever necessary.
6. Figures to the right indicate full marks.
7. Assume suitable data if necessary.
8. Use of non – programmable calculator is allowed.

1. a) Take a brief review of recent trends in design of machine tools. State the merits & demerits of these trends with respect to conventional design. **8**

b) Explain working motions of following machine tools with neat sketch. **6**
i) Lathe ii) Drilling
iii) Milling.

c) A lathe has four steps, the diameter of each being 90mm, 130mm, 170mm and 210mm. The countershaft pulley revolves at 100rpm. The gears A, B, C & D have 16, 48, 16, 48 teeth respectively. Find the various speeds of the spindle. **6**

2. a) Explain with neat sketch the design of antifriction guide ways in M.T.D. **10**

b) Explain in brief. **10**
i) Ray diagram
ii) Torso Variator.

3.	a)	Explain Force analysis of a shaping machine Ram with neat sketch.	**8**
	b)	Explain various types of Beds used in machine tool with their construction & design features with neat sketches.	**12**
4.	a)	Explain different methods of vibration control of machine tools.	**8**
	b)	Explain various steps in selecting a proper lubrication oil and it's properties.	**6**
	c)	Discuss the methods of adjusting clearance on slideways.	**6**
5.	a)	Explain design of sliding friction power screws on the basis of following points. i) Design for wear resistance. ii) Design for stiffness.	**8**
	b)	Explain overall static & dynamic rigidity of a machine tool.	**6**
	c)	Find the total axial load (static) to which ball recirculating power screw assembly can be subjected if $D_B = 4mm$, $R_O = 19mm$, Allowable contact stress σ_c (perm)=23,000 kg/cm^2 Assume n = 4 (number of Threads)	**6**
6.	a)	What are the functions of spindle unit ? Also explain it's requirements.	**8**
	b)	Discuss in detail how optimization of spacing between spindle support is achieved.	**8**
	c)	What is DNC ? What are it's advantages.	**4**
7.	a)	Explain the difference between NC, CNC and DNC machines.	**8**
	b)	Explain the different statements used in APT part programme in brief.	**8**
	c)	Explain in brief the automation in machine tools.	**4**
8.		Write short notes on the following **any four.** i) Machine tool drives. ii) Design of bases & tables. iii) Kinematic structure of gear shaping machine. iv) Stepped & stepless regulator. v) Manual part programming.	**20**

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चरित्र - 008

Seat Number

* 2 6 1 9 *

ELECTIVE - I
Tribology
(1040 / 1053 / 1140)

P. Pages : 2

Time : Three Hours **Max. Marks : 100**

Instructions to Candidates :

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3. Students should note, no supplement will be provided.
4. Answer **any five** questions.
5. Neat diagrams must be drawn whenever necessary.
6. Figures to the right indicate full marks.
7. Use of electronic pocket calculator is allowed.
8. Assume suitable data, if necessary.

1. a) Describe different theories of wear. **6**

b) What is friction ? Explain various types of friction. **8**

c) Explain any three friction measuring methods. **6**

2. a) Describe the equation for petroff's law. Also state assumption made. **10**

b) Explain the effect of pressure and temperature on viscosity of lubricating oil. **10**

3. a) State assumptions made while deriving Reynold's equation. Derive Reynold's equation for one dimensional flow. **10**

b) Explain design procedure for hydrodynamic journal bearings. **10**

4. a) Explain with neat sketch regimes of hydrodynamic lubrication. **10**

b) The following data is given for 360° hydrodynamic bearing.

Radial load	= 10 kN
Journal speed	= 1450 r.p.m
(l/d) ratio	= 1
Bearing length	= 50 mm
Radial clearance	= 20 microns
Eccentricity	= 15 microns
Specific gravity of lubricant	= 0.86
Specific heat of lubricant	= 2.09 kJ/kg°C

Calculate
i) The minimum oil film thickness.
ii) The coefficient of friction.
iii) The power loss in friction
iv) The viscosity of lubricant in CP.
v) The total flow rate of lubricant in ℓ/min.

5. a) Explain the construction, advantages, limitations and application of hydrostatic bearings. **10**

b) Following data is given for a hydrostatic thrust bearing **10**

Supply pressure	= 50bar
Shaft speed	=100 r.p.m
Shaft diameter	= 500 mm
Recess diameter	= 300 mm
Viscosity of lubricant	= 35 mpa s
Specific gravity of lubricant	= 0.86
Specific heat of lubricant	= 2 kJ/kg°C

Calculate
i) The load carrying capacity.
ii) The optimum oil film thickness.
iii) The total power loss.
iv) The flow rate of lubricant in ℓ /min
v) The temperature rise.

6. a) State and explain any five practical examples of squeeze film action. **10**

b) Derive an expression for volume flow rate of free air in case of aerostatic step bearing. **10**

7. a) Compare gas lubricated bearing with oil lubricated bearing. **8**

b) Describe the stability of hydrostatic bearings. **8**

c) Explain in brief requirements of gas lubrication. **4**

8. Write short notes on following. **20**
i) Fretting wear.
ii) Sintered metal bearing.
iii) Importance of viscosity index.
iv) Elastohydrodynamic lubrication.

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Seat Number

* 2 6 2 5 *

Design & Synthesis of Mechanism
(1080 / 1090)

P. Pages : 2

Time : Three Hours **Max. Marks : 100**

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4. Answer **any five** questions.
5. Figures to the right indicate full marks.
6. Use of non-programmable calculator is allowed.
7. Draw a neat sketch and assume suitable data if necessary.

1. Write short notes on. **20**

a) Curvature theory.

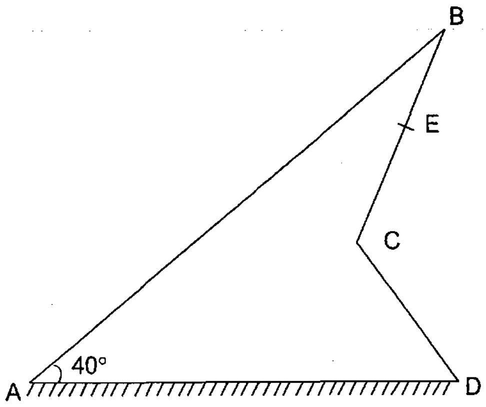
b) Planer Mechanism.

c) Spatial mechanism.

d) Osculating Circle.

2. What is Euler - Savary equation? What are its two forms? Also discuss their significance? **20**

3. Use the Bobillier theorem to determine the centre of curvature of the coupler curve of the point E of the four bar mechanism as shown in figure. The dimensions are AD=AB=60 mm, BC=CD=25 mm. AD is the fixed link and E is the midpoint of BC. **20**



4. Explain the following terms in detail. **20**

a) Hartmann construction.

b) Cubic of the stationary curvature.

5. Determine the Chebyshev's spacing for a four bar linkage generating the function $y = 2x^2 - 1$, in the range of $1 \le x \le 2$ where four precision points are to be prescribed. If the ranges in the i/p and o/p link rotating are given as $\Delta\phi = 50^\circ$ and $\Delta\psi = 90^\circ$. Find ϕ_2, ϕ_3, ϕ_4 and ψ_2, ψ_3, ψ_4. **20**

6. What is Kinematic synthesis? Discuss phases of synthesis in detail. **20**

7. Derive the Freudenstein's equation of displacement for a four bar linkage. **20**

8. Explain - **20**

a) Denavit hartenberg parameters.

b) Coupler curves.

c) Bermester points.

d) Dwell Mechanism.

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Seat Number

* 2 6 5 9 *

Mechanical Vibration

(1030 / 1040)

P. Pages : 3

Time : Three Hours **Max. Marks : 100**

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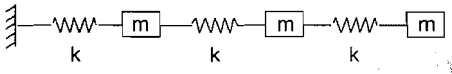
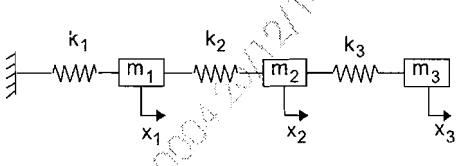
4. Answer **any five** question.
5. Figure to the right indicate full marks.
6. Assume suitable data if required.
7. Use of non programmable calculator is allowed.

1. a) Find natural frequency of the system as shown is fig. **10**



Also find mode shape. Assume K=2, m=5. Use matrix method.

b) Define stiffness and flexibility influence co efficient. Find Flexibility coefficient matrix for given system. **10**

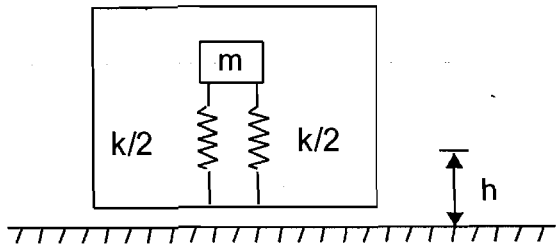


2. a) Show that Frequency of lateral vibrating string is $\frac{n\pi}{\ell}\sqrt{\frac{T}{p}}$, where l. **10**

Length of string. T-tension in string & p- density of string material.

b) Derive suitable expression for longitudinal vibration for a rectangular uniform c/s bar of length ℓ fixed at on end and free at the other end. **10**

3. a) An apparatus of mass m is shipped in a container as shown in fig. Container is dropped from a height h to a hard Floor. Find impulse response of the system. **10**



Find maxi. acceleration of mass. if K=125 kN/m, m=1000 kg, h= 0.35 m.

b) Explain Duhamel's integral method. **10**

4. a) While balancing a turbine rotor, following data has been obtained thro vibration measurements. **10**

Condition	Vib. Displacement		Phase Angle	
	At bearing A	At bearing B	Brg A	Brg B
Original	8.5	6.5	60°	205°
W_L=10 at 270°	6.0	4.5	125°	230°
W_R=12 at 180°	6.0	10.5	35°	160°

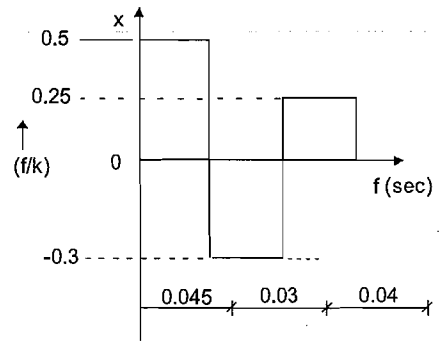
Find balancing weight and their positions.

b) Define vibration absorber and vibration isolator. **10**

5. a) Define Auto and cross correlations. What do you mean by PSD. Find unit of PSD and represent typical PSD function. **10**

b) Explain perturbation method. **10**

6. A system having a natural frequency of 15 MHz is allowed to explosive type of input which has been changed to equivalent approximate step shown in Fig. determine the phase plane plot ℓ displacement time plot. Find maxi displacement of the systems. **20**



7. Show that $mx+\frac{2Tx}{\ell}+\frac{AEx^3}{\ell^3}=0.$ **20**

For vibration of a string if mass 'm' is attached to the mid point and strech string with initial tension T. A and E are c/s of string and modulus of elasticity vesp. string displace by amount x. string extended through a distance $\delta\ell$

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Seat Number

* 2 6 6 1 *

Finite Element Analysis
(1040 / 1010)

P. Pages : 4

Time : Three Hours **Max. Marks : 100**

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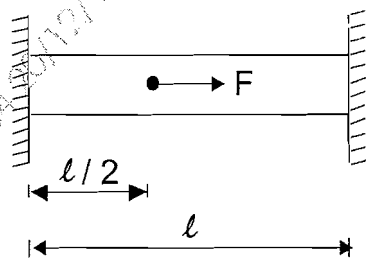
6. Assume suitable data if necessary.

1. a) A fixed beam of 10 mm^2 cross sectional area and 200 mm length as shown in figure is subjected to an axial force of 2000N at midpoint, using the Rayleigh - Ritz approximation determine - **10**

i) the displacement function. ii) the strain function.

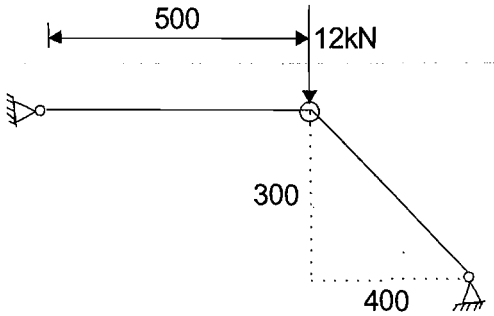
iii) the stress function.



b) Explain in details **10**

i) Elimination approach. ii) Penalty approach.

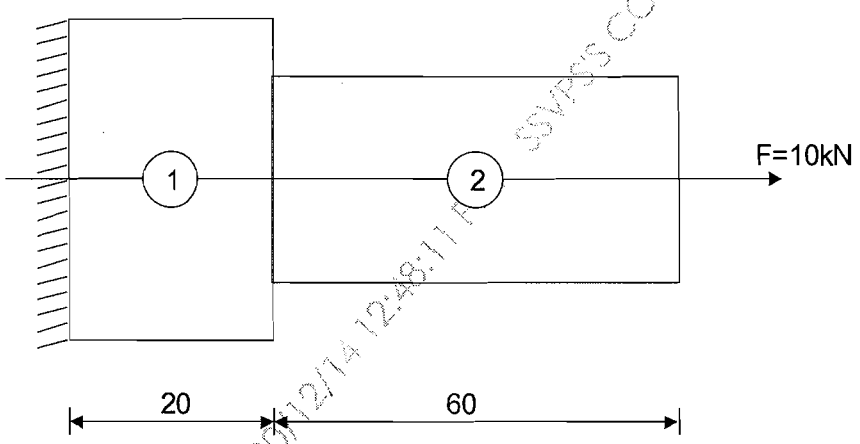
2. a) For the two bar truss as shown in figure, determine the displacements of and the stresses in the bar. Assume that E = 70GPa and A = 200 mm^2 for both members. **10**



b) Explain in details the steps of finite Element Analysis. **10**

3. a) A stepped bar is made of two materials joined together as shown in figure. The bar is subjected to an axial pull of 10KN. Determine the displacements and stresses of each of the section using one Dimensional spar element. Give that $E_1 = 200GPa, E_2 = 120GPa$ **10**

$A_1 = 200mm^2, A_2 = 180mm^2$



b) Define the following terms with sketch. **10**

i) Global coordinate system.

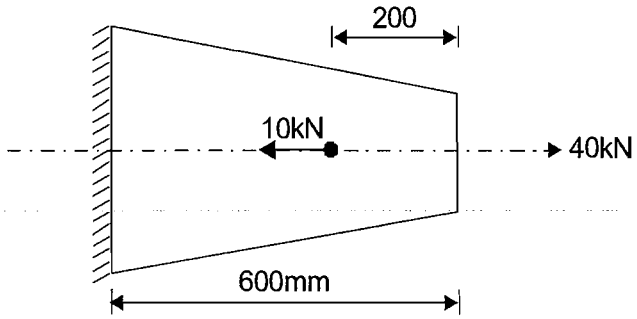
ii) Local coordinate system.

iii) Natural coordinate system.

iv) Surface tractions.

v) Body force.

4. a) **15**

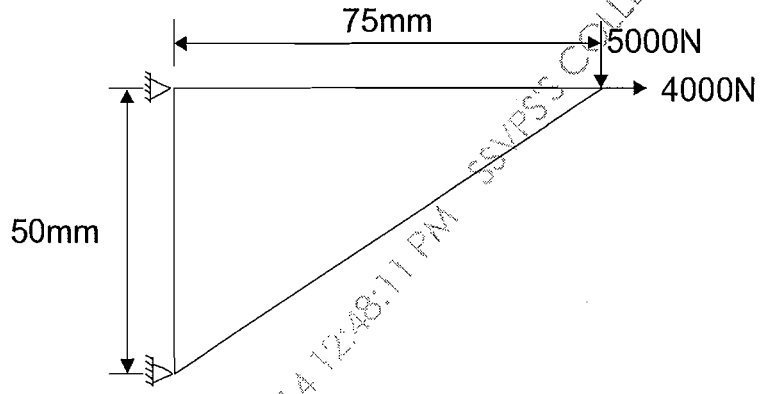


A steel tapered bar of 600 mm length has the cross sectional areas of 650 mm^2 and 350 mm^2 at two ends. It is fixed at large end and subjected to two axial forces of 40 KN as shown in figure. The modulus of elasticity for the bar material is $200\times10^3\ N/mm^2$. Model the bar with three finite elements and determine -

i) the nodal displacements. ii) the stresses in each element.
iii) the reaction force at supports.

b) Explain Discretization process used in FEA **5**

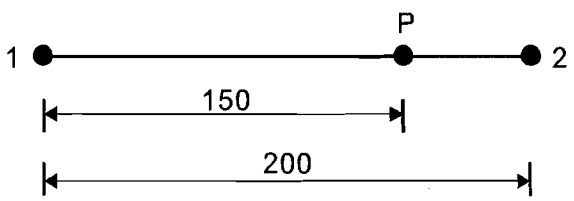
5. a) **20**



A triangular plate of size 75 mm x 50mm is subjected to inplane loads of 5000 N and 4000 N as shown in figure. The modulus of elasticity and poisson's ratio for plate material are $200\times10^3\ N/mm^2$ and 0.25 respectively. Model the plate with CST element; determine

i) the element stiffness matrix
ii) the nodal displacements
iii) the reaction forces at the supports.
iv) stresses in element (thickness of Plate =12.5 mm).

6. a) Temperature at node 1 is 100°C and at node 2 is 40°C. The length of element as shown in figure, is 200 mm Evaluate the shape function associated with node 1 and node 2. Calculate the temperature at point 'P' situated at 150 mm from Node 1. Assume linear shape function. **10**



b) Explain in details preprocessing, processing and post processing. List out the software used in FEM **10**

7. a) Determine the displacements and rotations for the joints for the portal frame as shown in figure. **20**

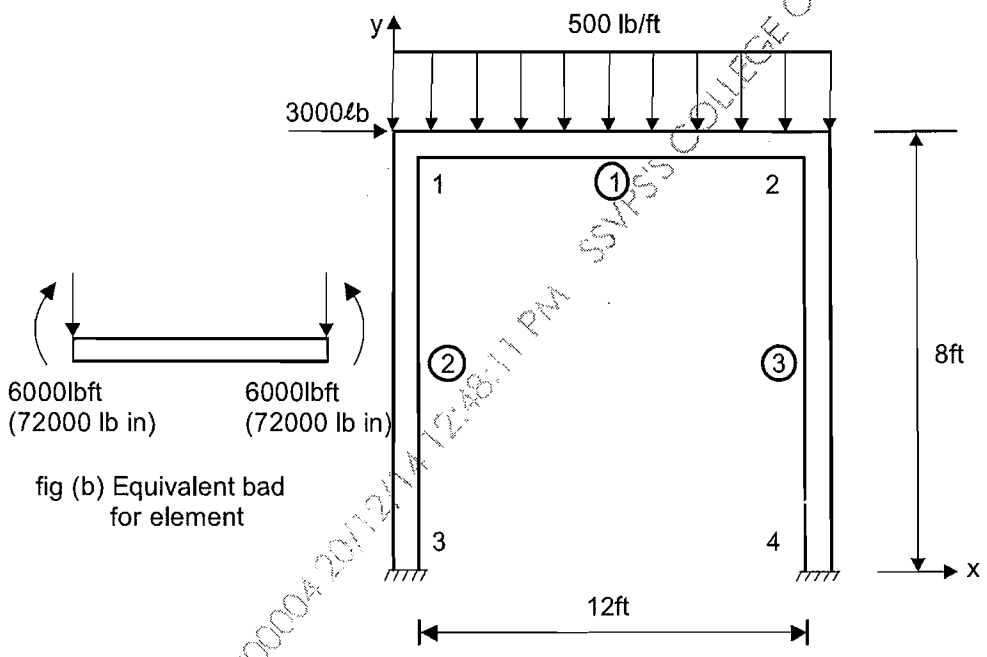


fig (a) Portal Frame

fig (b) Equivalent bad for element

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Seat Number

* 2 6 6 3 *

Optimization Techniques
(1060)

P. Pages : 2

Time : Three Hours **Max. Marks : 100**

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4. Write answers to **any five** questions.
5. Use of non-programmable calculator is allowed.
6. Assume suitable data wherever necessary.
7. Black figures to right indicate full marks.
8. Draw neat sketches wherever necessary.

1. a) State engineering applications of optimization. **10**

b) A uniform column of rectangular cross - section is to be constructed for supporting a water tank of mass M. It is required to minimize the mass of the column for economy and to maximize the natural frequency of traverse vibration of the system for avoiding possible resonance due to wind. Formulate the problem of designing the column to avoid failure due to direct compression and buckling. Assume b, d, l and 6 max as dimensions of column and permissible compressive stress **10**

2. a) State the necessary and sufficient conditions for the relative minimum of a function f (x) in single variable optimization problem. Prove the conditions. **10**

b) Find the second - order Taylor's series approximation of the function $f(x_1, x_2, x_3) = x_2^2\, x_3 + x_1\, e^{x_3}$ **10**

at the point $x = \begin{Bmatrix} 1 \\ 0 \\ -2 \end{Bmatrix}$

3. a) What is exhaustic search method? Write the steps of unrestricted search with fixed step size in elimination method. **10**

b) Find the minimum of function. **10**

$$f(\lambda) = 0.65 - \frac{0.75}{1+\lambda^2} - 0.65\lambda \tan^{-1}\frac{1}{\lambda}$$

using Quasi - Newton method with starting point $\lambda_1 = 0.1$ and the step size $\Delta\lambda = 0.01$ in central difference formulas. Use $\epsilon = 0.01$ for checking the convergence

4. a) Define Golden mean using procedure of Golden section method. **10**

b) Find the minimum of $f = \lambda^5 - 5\lambda^3 - 20\lambda + 5$ by the cubic interpolation method. **10**

5. a) Write a note on Random search methods. Write advantages of Random search methods. **10**

b) Minimize $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1 x_2 + x_2^2$ from the starting point $x_1 = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}$ using Powell's method. **10**

6. a) Explain reflection, contraction and expansion in simplex method of unconstrained optimization techniques. **10**

b) Minimize $f(x_1, x_2) = \frac{1}{3}(x_1 + 1)^3 + x_2$ **10**

Subject to

$$g_1(x_1, x_2) = 1 - x_1 \leq 0$$
$$g_2(x_1, x_2) = -x_2 \leq 0$$

7. a) Write basic approach of penalty function method. **10**

b) Find the dimensions of rectangular prism type box that has the largest volume when the sum of its length, width and height is limited to a maximum value of 60 inch. and its length is restricted to a maximum value of 36 inch. **10**

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चाचणी - 002

Seat Number

* 2 9 6 0 *

Computer Aided Design
(1020)

P. Pages : 2

Time : Three Hours **Max. Marks : 100**

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6. Figures to the right indicate full marks.
7. Use of non – programmable electronic pocket calculator, mollier charts, steam tables & statistical table are allowed.

1. a) What are the rules designed for implementing a graphics packages. **10**

b) What do you mean by raster scan systems ? Explain the working of a color CRT monitors. **10**

2. a) A point P (5, 5, 10) is observed by an observer located at (0, 0, -5). Find the Perspective projection of the point on the x-y plane. **5**

Prove that pure rigid body rotation is not commutative, while pure translation is. **5**

b) Develop the transformation for finding the reflection of a point with respect to the line ax + by + c =0. **10**

3. a) A cubic Bezier curve is to be divided by a designer in to two segments. Find the modified polygon points for each segments. **10**

b) Explain the basic elements of constructive solid geometry model. Discuss the main building operation of constructive solid geometry schemes with examples ? **10**

4. a) Write algorithm step to design disc brake. **10**

b) Write algorithm steps to design shaft with use of ASME code. **10**

5. a) An open cylindrical vessel is to be constructed to transport 80 m^3 of grain from a warehouse to a factory. The sheet metal used for the bottom and sides cost \$80 and \$10 per square meter, respectively. If it costs \$1 for each round trip of the vessel, find the dimensions of the vessel for minimizing the transportation cost. Assume that the vessel has no salvage upon completion of the operation. **15**

b) What is normality condition in a geometric programming problem ? **5**

6. The profit per acre of a farm is given by $20\times1+26\times2+4\times1$, $x2-4x^2_1-3x^2_2$ where x1 and x2 denote, respectively, the labour cost and the fertilizer cost. Find the values of x1 and x2 to maximize the profit. **20**

7. a) Using. Newton – Raphson's method, find $\sqrt[5]{50}$, connect to four decimals. **10**

b) The velocity of a car at intervals of 2 min are given below **10**

Time (Min)	0	2	4	6	8	10	12
Velocity (km/Hr)	0	22	30	27	18	7	0

Find the distance covered by the car in 12 minutes using Simpson 1/3rd rule.

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Seat Number

Design of Experiments & Analysis
(1080)

P. Pages : 2

Time : Three Hours **Max. Marks : 100**

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7. Use of electronic pocket calculator is allowed.
8. Assume suitable data, if necessary.

1. a) Describe the different types of research and state difference between an experiment and survey.

b) "Research is must concern with proper fact finding analysis and evolution". Do you agree with this statement ? Give reasons in support of your answers. **20**

2. a) Explain and illustrate the procedure of selecting a random sample.

b) Describe the possible sources of error in measurements in context of Research. **20**

3. a) Explain the different method of collecting data. List its merits and demerits.

b) How do you define a research problem ? Give four examples to illustrate your answer. **20**

4. a) Write the reasons for using Heuristics in research modeling. Explain the various Heuristics methods.

b) Give the classification of simulation models and explain the steps of simulations. **20**

5. a) Explain terms interaction with linear graphs and triangular table.

b) Design an experiment to study four factors *A, B, C* and *D* with three interactions A x C, C x D and A x D. Select orthogonal arry and identify columns for three interactions. **20**

6. a) Explain the ANOVA technique with the help of suitable example.

b) Write a note on : **20**
i) Steps in Design of experiment
ii) Confidence interval.

7. a) Mention different types of report, particularly list out the difference between a technical report and a popular report.

b) Write short note on : **20**
i) Characteristics of a good research report
ii) Bibliography and its importance in context to Research report.

8. In an experiment involving four factors *A, B, C, D* and one interaction *A* x *B*. Each trial condition is repeated three times and the observations recorded as shown in Table 1. **20**
i) Determine the total sum of squares and the sum of squares for factor *A*.
ii) Assuming the "bigger is better" quality characteristic, transfer the result of trial 1 into corresponding S/N ratio.
iii) Prepare the ANOVA on the observed results of an experiments and determine the percentage contribution of each factor from ANOVA table.

Table 1

Column Trial	A1	B2	AXB 3	C4	D5	6	7	R1	R2	R3
Trial 1	1	1	1	1	1	0	0	45	56	64
Trail 2	1	1	1	2	2	0	0	34	45	53
Trial 3	1	2	2	1	1	0	0	67	65	60
Trial 4	1	2	2	2	2	0	0	45	56	64
Trial 5	2	1	2	1	2	0	0	87	81	69
Trial 6	2	1	2	2	1	0	0	78	73	68
Trial 7	2	2	1	1	2	0	0	45	56	52
Trial 8	2	2	1	2	1	0	0	42	54	47

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चाचणी - 004

Seat Number

* 2 9 6 2 *

System Dynamics & Simulation
(1070)

P. Pages : 3

Time : Three Hours **Max. Marks : 100**

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7. Use of electronic pocket calculator is allowed.
8. Assume suitable data, if necessary.

1. a) Classify different types of models of a system with suitable example. **20**

b) Describe the process of Model Testing in context with system dynamics.

2. a) What are the basic steps to be followed while making a model? **20**

b) Name several entities, attributes, activities for the following systems.

A barber shop.

A cafeteria.

A grocery shop.

A fast food restaurant.

A Petrol Pump.

3. a) What is simulation? Describe its advantages in solving the problems. Give its main limitations with examples. **20**

   b) Explain Monte Carlo method and give the situations where these methods are useful. Explain in brief the advantages and disadvantages of Monte Carlo methods.

4. a) What is continuous simulation? Explain with the help of suitable example. **20**

   b) Explain exponential distribution and its role in simulation.

5. a) Describe with a suitable example a discrete-event simulation. **20**

   b) Write a short note on M/M/c models and their applications.

6. a) Consider a assembly line with five stations. Demonstrate that it is a queueing system by describing its components. **20**

   b) Identify the customers and the servers in the queueing system in each of the following simulation.

      a) A grouping of semiautomatic machines assigned to one operator.

      b) The materials-handling equipment in a factory area.

      c) A plumbing shop.

      d) A job shop producing custom orders.

      e) A secretarial typing pool.

7. a) Give a general structure of the queuing system and explain it. Prove that if the number of arrivals follows Poisson process, then the inter-arrival times follow the exponential distribution. **20**

   b) An insurance company has three claim adjusters in its branch office. People with claims against the company are found to arrive in a Poisson fashion at an average rate of 20 per 8-hour day. The amount of time that an adjuster spends with a claimant is found to have an exponential distribution with mean service time 40 minutes. Claimants are processed in the order of their appearance.

      i) How many hours per week can an adjuster expect to spend with the claimants?

      ii) How much time, on the average, does a claimant spend in the branch office?

8. a) Discuss the various software's and their use in simulation. **20**

b) Project arrives every 20 minutes at Design_Queue (capacity: 100), spend 30 minutes in Deign, 15 minutes in Desing_Review. Not all drawings pass the Review. 10% head to Rework, Rework will take 15 minutes per Project and then back to Design_ Review while remaining 90% continue to Produce_Drawings that takes 20 minutes and then Exit the system.
Formulate the problem so as to solve the same by using any of the simulation software.
Discuss the parameters and their values that are required to be set in the software.
Explain the steps to be followed so that it can be solved by using the software.

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Seat Number

* 2 9 6 3 *

Machine Design
(1030)

P. Pages : 3

Time : Three Hours **Max. Marks : 100**

Instructions to Candidates :

1. Do not write anything on question paper except Seat No.
2. Answer sheet should be written with black ink only. Graph or diagram should be drawn with the same pen being used for writing paper or black HB pencil.
3. Students should note, no supplement will be provided.
4. Answer All questions.
5. Neat diagrams must be drawn wherever necessary.
6. Figures to the right indicate full marks.
7. Use of non-programmable electronic pocket calculator is allowed.
8. Assume suitable data wherever necessary.

1. a) A mild steel shaft of 50 mm diameter is subjected to a bending moment of 2000 N-m and a torque T. If the yield point of the steel in tension is 200 MPa, find the maximum value of this torque without causing yielding of the shaft according to **8**

   1) The maximum principal stress;

   2) The maximum shear stress; and

   3) The maximum distortion strain energy theory of yielding.

   b) Explain the following. **8**

   i) Maximum shear stress theory of Failure.

   ii) Hertz contact stress theory.

2. a) Define and explain the terms stress intensity factor 'K' and critical stress intensity factor 'K_{IC}'. **8**

b) For specimens of sheet of varying thickness K_{IC} value very as tabulated below: **8**

Thickness't'mm	0.5	0.97	2	5	10	15
$K_{IC}\left(MPa\sqrt{m}\right)$	42	80	118	58	40	37

suggest a possible reason for variation of K_{IC}. If stress in a 2 mm thick sheet is 285 MPa, find critical crack length 'a' that would lead to catastrophic failure.

3. a) A machine component is subjected to fluctuating stress that varies from 40 to 100N/mm^2. The corrected endurance limit stress for the machine component is 270N/mm^2. The ultimate tensile strength and the yield strength of the material are 600 and 450 N/mm^2 respectively. Find the factor of safety using, Gerber theory, Soderberg line, and Goodman line and also find factor of safety against static load. Comment on the results obtained. **10**

b) A cantilever beam has a rectangular cross section 4.5 cm wide & 10 cm deep. The length is 130 cm with a load of 10,000 N on it at the end. The material is 0.3 carbon steel with $\eta = 7$ & $\beta = 40\times10^{-35}\left(cm^2/N\right)^{\eta}$ day. Find permanent deflection after 12 years of service. **8**

4. a) What is Reliability? Prove that Reliability with respect $R(t) = e^{-\int_0^t h(t)dt}$. **8**

b) A machine has a failure rate of 1×10^{-6} failure/ hour. What is its reliability for a period of 400 hours. If there are 1000 items in the test, how many failure are expected in 400 hours. Assume a constant failure rate. **8**

5. a) Comment on the use of **8**

i) Ceramics.

ii) Polymer.

iii) Ceramic metals in mechanical engineering. What advantage can one claim in favor of use of composites?

b) Calculate [A], [B], [D] matrices for [+45 | -45] laminate with the following lamina properties. **8**

$E1 = 140GPa \quad E2 = 10GPa \quad E6 = G_{12} = 5GPa \quad \mu_{12} = 0.3 \quad d = 0.125mm$

6. Explain with suitable practical examples. **18**

a) Design for manufacturing.

b) Safe life & fail safe design.

c) Six sigma techniques in machine design.

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