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08MMD/MDE22

Second Semester M.Tech. Degree Examination, December 2010
Advanced Machine Design

25

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions.***
2. ***Use of machine design data hand book is permitted.***
3. ***Missing data if any, may be suitably assumed.***

1 a. Discuss different theories of failure used for designing with uneven brittle materials. **(06 Marks)**

b. At a critizal point in a stressed body, the state of stress is given by : $\sigma_x = 60$ MPa , $\sigma_y = -40$ MPa , $\tau_{xy} = 30$ MPa. Material used is cast iron with $\sigma_{ut} = 300$ MPa and $\sigma_{uc} = -900$ MPa. Determine the factor of safety using :
i) Coulomb – Mohr theory and ii) Modified Mohr theory.
Comment on the results. **(14 Marks)**

2 a. List the different fatigue design criteria and explain each of them briefly, with examples. **(08 Marks)**

b. With neat sketches, briefly explain different fatigue testing machines. **(08 Marks)**

c. Write a note on fatigue test specimens. **(04 Marks)**

3 a. Explain the method of obtaining median S – N curve for a given material. **(06 Marks)**

b. Using constant life diagram, yielding envelope under fatigue loading, explain the effect of tensile and compressive mean stress. **(06 Marks)**

c. An un notched circular rod with a diameter of 10mm is subjected to constant amplitude bending with $S_m = 175$ MPa. Material is alloy steel with $S_u = 1400$ MPa, $S_y = 1200$ MPa and $S'_y = 1000$ MPa. If the surface finish factor is 0.88, estimate the value of S_a, S_{max}, S_{min} and R for a median fatigue life of 90,000 cycles and no yielding. **(08 Marks)**

4 a. Explain the importance of strain – controlled testing in fatigue design. **(04 Marks)**

b. Define transition fatigue life and obtain an expression for transition fatigue life. Illustrate it through appropriate plots. **(08 Marks)**

c. Determine transition fatigue life for smooth uniaxial test specimens of RQC – 100 steel. Also determine, the elastic, plastic and total strain amplitude at this life. Given the data for RQC – 100 steel :
$S_u = 931$ MPa , $E = 207$ GPA , $\epsilon'_f = 0.66$, $\sigma'_f = 1240$ MPa , $b = -0.07$, $c = -0.69$. **(08 Marks)**

5 a. Explain with necessary plot the relationship among crack length 'a', applied cycles 'N' and stress levels. What are the limitations of this plot? **(04 Marks)**

b. Discuss the effect of meanstress on fatigue crack growth behavior. **(04 Marks)**

c. A very wide and thin plate of steel is subjected to constant amplitude uniaxial cyclic loads that produce nominal stresses varying from $S_{max} = 300$ MPa to $S_{min} = -60$ MPa. The monotonic properties for this steel are $S_y = 650$ MPa , $S_u = 700$ MPa , $E = 207$ GPa , $K_c = 105$ MPa $\sqrt{m}$. If an initial through thickness edge crack of 1.4 mm length existed in the plate, what fatigue life would be attained? Take $n = 3.0$ and $A = 6.9 \times 10^{-12}$ m/cycle. **(12 Marks)**

6 a. List different factors contributing to scatter in fatigue test data. **(04 Marks)**

b. Explain briefly as to how will statistical methods help in analyzing the fatigue test data. **(04 Marks)**

c. List different statistical distributions used in fatigue analysis and explain each of them briefly. **(12 Marks)**

7 a. Explain the terms :

i) Cumulative damage and

ii) Spectrum loading. **(04 Marks)**

b. What are the different measures used to quantify fatigue damage? Explain. **(03 Marks)**

c. Briefly explain the rain flow method of cycle counting. What are its advantages? **(05 Marks)**

d. A rod is made of a steel with S_u = 510 MPa and a fatigue limit of S_f = 300 MPa defined at 10^6 cycles. The rod is subjected to three fully reversed blocks of nominal stress cycling, as indicated below. The blocks are them repeated. Predict the expected fatigue life of the part if the part is smooth.

S_a (MPa)	350	300	200
Applied Number of Cycles	1	5	10,000

Take $\sigma_f' = 800\,\text{MPa}$, $b = -0.071$. **(08 Marks)**

8 a. Explain the mechanism of

i) Adhesive wear

ii) Abrasive wear. **(08 Marks)**

b. Explain the phenomenon of surface fatigue. **(04 Marks)**

c. Derive an expression for pressure distribution in a cylindrical contact and show the pressure distribution. **(08 Marks)**

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08MEA/MMD/MDE23

Second Semester M.Tech. Degree Examination, December 2010
Dynamics and Mechanism Design

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Determine the mobility of the mechanisms shown in Fig.1(a). **(08 Marks)**

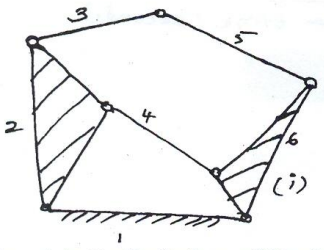
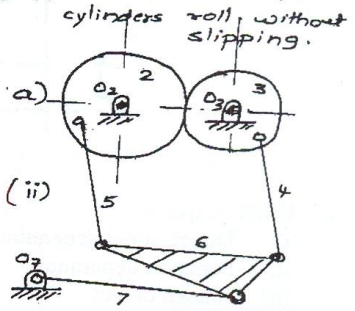


Fig.Q.1(a)



Also, state the limitations of Kutzbach criterion.

b. Determine the angular velocities of link 4 and link 5 of the mechanism shown in Fig.Q.1(b). Use the auxiliary point method. **(12 Marks)**

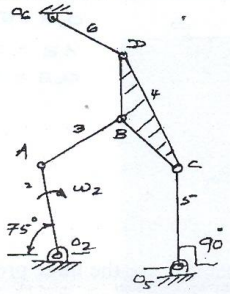


Fig.Q.1(b).

Given : $\omega_2 = 10$ rad/s
$O_2A = 7.5$ cm, AB = 5cm
BC = 7.5 cm, $O_5C = 6.3$ cm
CD = 10 cm, BD = 5cm
$O_6D = 5$ cm, $\angle O_2AB = 110^\circ$
$\angle ABC = 115^\circ$, $\angle O_6DB = 117^\circ$

2 a. Briefly explain ,
i) Principle of virtual work.
ii) Generalized coordinates. **(08 Marks)**

b. A mass m is suspended by a massless wire of length r = a + b Cos wt, a > b > 0, to form a spherical pendulum. Find the equations of motion, applying D'Alembert's principle. **(12 Marks)**

3 a. Derive Lagrange's equation from D'Alembert's principle. **(10 Marks)**

b. Three equal uniform rods AB, BC and CD are freely jointed at B and C and the ends A and D are fastened to smooth fixed pivots as shown in Fig.3(b). The frame being at rest in the form of a square, a blow 'J' is given perpendicular to AB at its middle point and in the plane of the square. Show that the energy set up is $30J^2/40$ m where m is the mass of each rod. Use Lagrange's equations. **(10 Marks)**

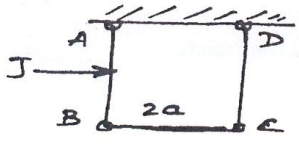


Fig.Q.3(b).

AD = BC
= AB = CD
= 2a

4 a. Consider the motion of top, relative to the reference plane XYZ, which rotates at a constant rate of ω rad/s about its Z axis. Use the Euler angles as coordinates defined relative to the xyz frame, and obtain the differential equation of motion. Indicate the gyroscopic terms. **(10 Marks)**

b. The natural period of a spring – mass system is 1sec. It is subjected to a pulse motion as shown in Fig.Q.4(b). Plot the phase plane response. **(10 Marks)**

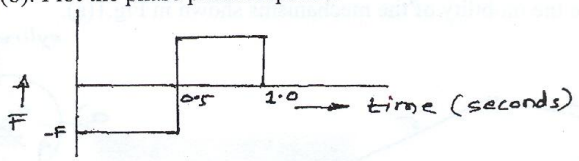


Fig.Q.4(b).

5 a. Briefly explain :
i) Dimensional generation
ii) Function generation
iii) Branch defect
iv) Polode. **(12 Marks)**

b. Draw the inflection circle for the motion of the coupler of a 4 – bar mechanism shown in Fig.5(b). Mention the significant property of inflection circle. **(08 Marks)**

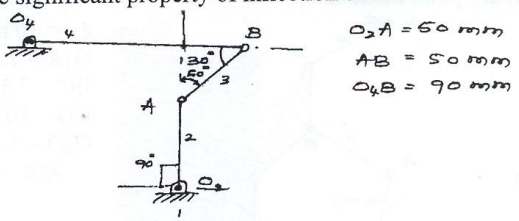


Fig.Q.5(b).

6 a. Synthesize graphically a four – bar mechanism, for the three precision points, given :
$\theta_{12} = 30^\circ$, $\phi_{12} = 35^\circ$
$\theta_{23} = 45^\circ$, $\phi_{23} = 30^\circ$.
θ = input angles , ϕ = output angles. **(12 Marks)**

b. Explain briefly 'cognate' linkages. **(08 Marks)**

7 Synthesize a four bar linkage that will, in one of its positions, satisfy following values for the angular velocities and accelerations.
$y = x^{1.2}$, $1 \le x \le 5$.
Use Chebychev spacing for three precision points. Take $\phi_o = 30^\circ$, $\psi_o = 60^\circ$ and $\Delta\phi = \Delta\psi = 90^\circ$. **(20 Marks)**

8 Write short notes on :
a. Eularian angles.
b. Gyroscopic action in machines.
c. Holonomic and non – holonomic constraints.
d. Bloch's method of synthesis. **(20 Marks)**

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08MMD/MDE252

Second Semester M.Tech. Degree Examination, December 2010
Theory of Plasticity

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

28

1 a. Define the following :
   i) Stress invariants
   ii) Octahedral stresses
   iii) Hydrostatic and deviotoric stresses. **(06 Marks)**

   b. The state of stress at a point is given by,

$$\sigma_{ij} = \begin{bmatrix} 9 & 6 & 3 \\ 6 & 5 & 2 \\ 3 & 2 & 4 \end{bmatrix} \text{MPa}$$

   Determine the principal stresses and principal directions. **(10 Marks)**

   c. Explain the cubical dilatation and obtain its expression in terms of linear strains. **(04 Marks)**

2 a. Enumerate the various types of materials, encountered in practice, from the plastic flow point of view. Also sketch the corresponding mechanical model. **(12 Marks)**

   b. Explain the yield phenomenon. Discuss the yield conditions, using Von Mises yield criteria. **(08 Marks)**

3 a. Explain the Haigh westergaard stress space representation of yield criteria. **(10 Marks)**

   b. Explain 'Taylor and Quinney's' experiment for the verification of yield criteria. **(10 Marks)**

4 a. Write a note on subsequent yield locus. **(08 Marks)**

   b. Explain and arrive the plastic stress – strain relation of Prandtl – Reuss. **(12 Marks)**

5 a. A cantilever beam of length 'L' carries an end load 'W'. The stress – strain relationship for the beam material is given by $\sigma = H \epsilon^n$. Determine the end deflection. **(10 Marks)**

   b. A solid circular shaft of radius 120 mm is subjected to transmit 600 kW at 540 rpm. The maximum torque is 30% greater than the mean torque. If the shear stress – strain curve for the shaft material is given by $\tau = 280\ V^{0.25}$, determine the maximum stress induced in the shaft and the corresponding angle of twist. What would be these values, if the stress strain curve is a linear one? Tale, G = 84 GPa. **(10 Marks)**

6 a. Derive an expression for the stresses in the material during strip extrusion. Also sketch the stress distribution. **(15 Marks)**

   b. Show that the maximum reduction in wire drawing is only 63.33%. **(05 Marks)**

7 a. What do you understand by a slipline? How slipline nets can be drawn? **(10 Marks)**

   b. Determine the force on the rolling during rolling, with one driven roll. **(10 Marks)**

8 Write short notes on :
   a. Convexity of yield locus
   b. Yield criteria for an anisotropic material
   c. Hodographs
   d. Lower bound theorem. **(20 Marks)**

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