USN | | | | | | | | | | **10MMD/MDE23**

Second Semester M.Tech. Degree Examination, June/July 2011
Dynamics and Mechanism Design

31

Time: 3 hrs. Max. Marks:100

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

1 a. What is an equivalent linkage? What are the advantages of equivalent linkage? **(06 Marks)**

b. State Grashaf's law and specify the conditions for obtaining different kinematic inversion in a quadratic chain. **(08 Marks)**

c. Write down the main differences between
   i) Plane, spherical and spatial mechanism
   ii) Analysis and synthesis. **(06 Marks)**

2 a. Explain the holonomic and non – holonomic constraints, give examples. **(06 Marks)**

b. Explain the virtual displacement, virtual work and principle of virtual work. **(08 Marks)**

c. Particles, 1 and 2 are connected by a rigid rod of length ℓ as shown in Fig. Q2(c). The configuration of the system can be given by the cartesian coordinates (x_1, y_1, x_2, y_2) or by the generalized coordinates (x, y, θ). Write the transformation equations giving the cartesian coordinates in terms of the generalized coordinates. $Q_4 \equiv L$ and evaluate the Jacobian $\dfrac{\partial(x_1, y_1, x_2, y_2)}{\partial(x, y, \theta, q_4)}$. Solve for the generalized coordinates in terms of cartesian coordinates. **(06 Marks)**

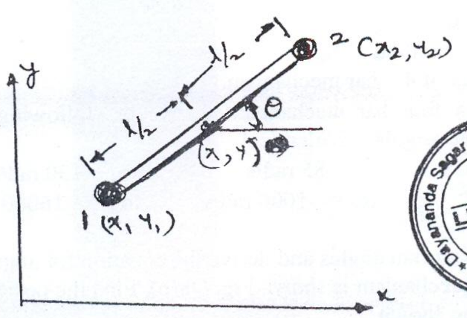


Fig. Q2(c)

3 a. Derive the Lagrange's equation of motion. **(10 Marks)**

b. Using the Hamilton principle, find the equation of motion of the system as shown in Fig. Q3(b). **(10 Marks)**

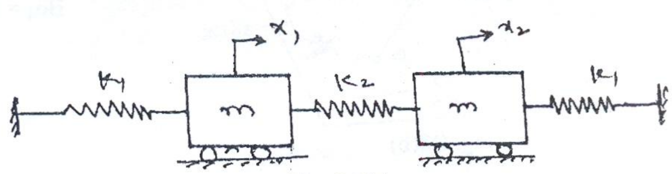


Fig. Q3(b)

4 a. A particle of mass m can slide without friction on the inside of a small tube bent in the form of circle of radius r. The tube rotates about the vertical diameter at a constant rate ω rad/ sec. Obtains the governing differential equation using the Lagrangian. **(10 Marks)**

b. A spring a mass system initially at rest is subjected to excitation of forcing function as shown in Fig. Q4(b). Find the response in phase plane method. **(10 Marks)**

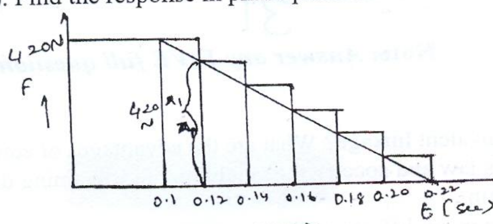


Fig. Q4(b)

5 a. Explain how the slider crank mechanism can be synthesized for two given positions, with help of sketch. **(10 Marks)**

b. Write the equations to obtain optimum transmission angle with crank rocker mechanism. **(06 Marks)**

c. Explain in brief, the function generation, path generation and body guidance. **(04 Marks)**

6 a. Synthesize a function generator to generate a function $y = \log_{10}x$ with $10 \le x \le 50$. The input lever to have starting position at 30° and a swing of 90°. The output lever to have starting position at 45° and a swing of 100°. Length of the input lever be 30 mm. Use three position synthesis and chebychev spacing. **(10 Marks)**

b. Describe the Freudensteins equation for four bar linkages. **(10 Marks)**

7 a. Write note on :

i) Overbuy method

ii) Cognates of 4 – bar mechanism. **(10 Marks)**

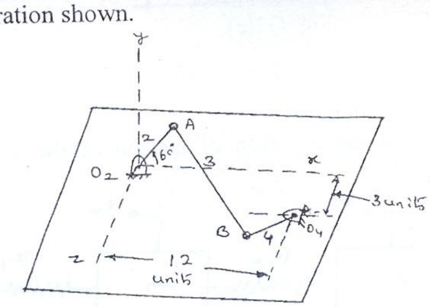
b. Synthesize a four bar mechanism to give the following values of ω's and α's [angular velocities and angular accelerates].

$\omega_2 = 200$ rad/s $\quad \omega_3 = 85$ rad/s $\quad \omega_4 = 130$ rad/s

$\alpha_2 = 0$ rad/s^2 $\quad \alpha_3 = -1000$ rad/s^2 $\quad \alpha_4 = -16000$ rad /s^2. **(10 Marks)**

8 a. Define the Eulerian angles and derive the equation for angular velocities. **(10 Marks)**

b. A RGGR mechanism is shown Fig. Q8(b). Find the position of all the moving links in the configuration shown. **(10 Marks)**



$Ao_2 = 4$ units

$AB = 15$ units

$Bo_4 = 10$ units

Fig. Q8(b)

* * * * *

USN | | | | | | | | | | |

10MMD/MDE24

Second Semester M.Tech. Degree Examination, June/July 2011

Advanced Theory of Vibrations

Time: 3 hrs. 33 Max. Marks:100

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

1 a. A mass of 2kg is supported on an isolator having a spring scale of 2940 N/m and viscous damping. If the amplitude of free vibration falls to one half its original value in 1.5 seconds, determine the damping coefficient of isolator. **(10 Marks)**

b. Two rail road cars have a mass of 10 tonnes each. They are coupled by springs of total stiffness 2.94×10^6 N/m. Determine the natural frequencies of the system. **(10 Marks)**

2 a. A spring-mass-dashpot system is subjected to a step function excitation ($F = F_0$ at $t = 0$). Find the response of the system using Laplace Transformations. **(10 Marks)**

b. Obtain a response of a spring-mass system subjected to force excitation shown in Fig.Q2(b).

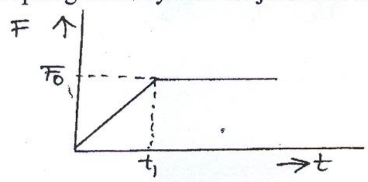


Fig.Q2(b)

(10 Marks)

3 a. A washing machine of mass 50kg operates at 1200 rpm. Find the maximum stiffness of isolator that provides 75% isolation. Assume damping ratio to be 7 percent. **(10 Marks)**

b. The natural frequency of vertical vibration of fan and its supports shown in Fig.Q3(b) coincides with the frequency of operation of fan which in 1200 rpm. The fan has an unbalance of 1kgcm. It is proposed to reduce the resonant condition by attaching a vibration absorber to fan housing. It is specified that, fundamental natural frequency of the resultant system should be nine-tenth of the forcing frequency. Find the required ratio of absorber mass to main mass. If the weight of the main mass is 225 kg, find the weight and spring constant of absorber. **(10 Marks)**

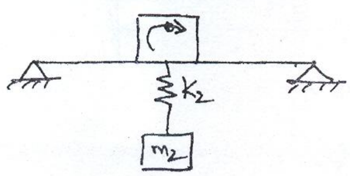


Fig.Q3(b)

4 a. A commercial type vibration pick-up has a natural frequency of 5.75 cps and a damping factor of 0.65. What is the lowest frequency beyond which the amplitude can be measured within one percent error? **(10 Marks)**

b. Write short notes on : i) Vibration exciters ii) Signature analysis. **(10 Marks)**

5 a. Explain the following machine maintenance techniques :
i) Breakdown maintenance
ii) Preventive maintenance
iii) Condition based maintenance. **(10 Marks)**

b. Explain experimental modal analysis with reference to basic idea and necessary equipment. **(10 Marks)**

6 a. Explain at least five different comparisons between linear and non-linear systems. **(10 Marks)**

b. Apply the perturbation method to simple pendulum with sin θ replaced by $\theta - \frac{\theta^3}{6}$. Use only the first two terms of the series. Determine the equation for the period of simple pendulum as a function of its amplitude. **(10 Marks)**

7 a. Calculate the mean square value, the variance and standard deviation of the function shown in Fig.Q7(a). **(10 Marks)**

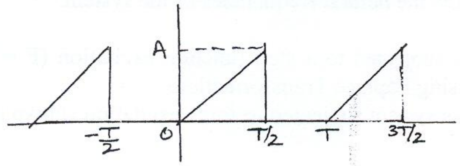


Fig.Q7(a)

b. Define the following terms :
i) Auto correlation function
ii) Ergodic process
iii) Power spectral density function
iv) Mean value and variance **(10 Marks)**

8 A uniform string of length l and a lange initial tension s, stretched between two supports, is displaced laterally through a distance a_0 at the centre as shown in Fig.Q8 and is released at t = 0. Find the general solution and from the general solution obtain the equation of motion for the string. **(20 Marks)**

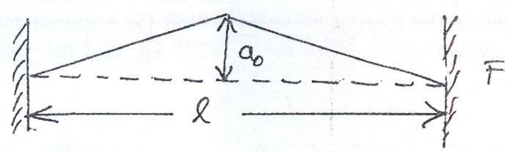


Fig.Q8

* * * * *

USN | | | | | | | | | | |

10MMD/MDE252

Second Semester M.Tech. Degree Examination, June/July 2011
Theory of Plasticity

35

Time: 3 hrs. Max. Marks:100

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

1 a. What are stress invariants? Write expression for the same in terms of rectangular Cartesian and principal stress components. **(06 Marks)**

b. With a neat sketch, explain 3D Mohr's circle. **(06 Marks)**

c. State of stress at a point is given by:

$$S_{ij} = \begin{bmatrix} -5 & -6 & 5 \\ -6 & 3 & -4 \\ 5 & -4 & 2 \end{bmatrix} \text{ MPa.}$$

Determine: i) Hydrostatic stress, ii) Deviatoric stress tensor, iii) Octahedral stresses, iv) Representative stress. **(08 Marks)**

2 a. Write idealized stress-strain diagram for the following material models indicating their equivalent mechanical models: Linear elastic, Rigid-strain hardening, Elasto-plastic, Elasto-plastic with strain hardening, Visco elastic. **(05 Marks)**

b. What is cubical dilatation? Obtain an expression for the same in terms of linear strains. **(05 Marks)**

c. Strain components at a point are $\epsilon_x = 6, \epsilon_y = \epsilon_z = 0, \gamma_{xy} = 1, \gamma_{yz} = 3, \gamma_{zx} = 6$.

Determine: i) Strain invariants, ii) Principal strains, iii) Direction of maximum principal strain, iv) Representative strain. **(10 Marks)**

3 a. What is Pie-plane? Explain how yield criteria can be represented on this plane. **(05 Marks)**

b. Explain representation of Traces of yield surfaces in 2D stress space. **(08 Marks)**

c. A thin walled tube of mean radius 100mm and thickness 4mm is subjected to a torque of 10kNm. If yield strength of tube material is 122.5MPa, determine value of axial force P to be applied to tube so that tube starts yielding according to Mises yield criteria. **(07 Marks)**

4 a. Derive expressions of Prandtl-Reuss theory assuming coaxiality of strain increment tensor and deviatoric stress tensor. **(08 Marks)**

b. Explain Lode's experimental verification of plastic stress-strain relationship. **(06 Marks)**

c. Define Normality rule. Explain the rule as applied to Von-Mises theory. **(06 Marks)**

5 a. For a beam with non linear stress-strain curve derive equation for bending moment for the case of elasto-plastic yielding. **(06 Marks)**

b. For a bar with nonlinear stress-strain behavior, derive Torsion equation in the form $\frac{T}{J_n} = \frac{\tau}{r^n} = F\left(\frac{\theta}{l}\right)^n$ neglecting elastic shear strain. **(06 Marks)**

c. A cantilever beam 80mm wide and 100mm deep is 2m long. Yield strength of the material is 250MPa. Assuming linear stress-strain behavior, determine value of concentrated load applied at free end if i) Outer shell up to 30mm depth yields, ii) Whole of beam yields. Also determine shape factor. **(08 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

6 a. Derive expression for stresses in extruding a rod. Sketch their variation and find the maximum reduction. **(10 Marks)**

b. A strip is down through tapered dies in a state of plane strain. If the initial width of strip is 6.25mm, final width 5.625mm and thickness 10mm, determine the draw stress when i) back pull is 150N ii) back pull is zero. Given semi die angle = 10^0, coefficient of friction = 0.03. **(10 Marks)**

7 a. Derive continuity equations for incompressible two dimensional flow considering slip lines. **(08 Marks)**

b. List properties of slip lines. **(06 Marks)**

c. Name different methods of construction of slip lines and explain any one. **(06 Marks)**

8 Write short notes on any four:

a. Levy-Mises plastic flow equations.

b. Yield criteria for anisotropic material.

c. Non linear bending equation.

d. Upper bound theorem.

e. Yield surface in 3D stress space. **(20 Marks)**

* * * * *

USN | | | | | | | | | |

08MMD/MDE22

Second Semester M.Tech. Degree Examination, June/July 2011

Advanced Machine Design

30

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions.***
2. Use of design data handbook is permitted.
3. Any missing data may suitably be assumed.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. Define the terms mechanical failure and failure mode. Describe the meaning of a synergetic mode, with an example. **(08 Marks)**

b. A differential element is subject to the stresses σ_x = 69 MPa, σ_y = -138 MPa and τ_{xy} = -138 MPa. The material is uneven and has strengths S_{ut} = 345 MPa, S_y = 276 MPa and S_{uc} = 621 MPa. Calculate the factor of safety and draw the failure boundary, using the modified Mohr theory with the given stress state. Also draw the load line. **(12 Marks)**

2 a. Explain the mechanism of fatigue failure. **(08 Marks)**

b. With a neat sketch, explain the method of obtaining the fatigue strength, using a rotating-bending fatigue testing machine. Also explain the method of obtaining S-N-P plots using the above machine. **(12 Marks)**

3 a. Explain the effect of mean stress on S-N behaviour of materials. **(06 Marks)**

b. A smooth uniaxial bar is subjected to a minimum stress of 35 MPa in compression. The corrected fatigue strength in completely reversed axial loading was 220 MPa. The ultimate tensile strength of the material was 500 MPa and the true fracture strength was 600 MPa. Using the modified Goodman criterion, determine the maximum tensile stress, the bar will withstand without failure in 10^6 cycles. Repeat the calculation using the Marrow criterion. Comment on the difference between the two calculations. **(08 Marks)**

c. Explain the effect of the following on the S-N behaviour:
i) Surface finish ii) Size iii) Heat treatment. **(06 Marks)**

4 a. Explain the following :
i) Strain-life curve
ii) Transition fatigue life
iii) Mean stress effects on strain life.

(10 Marks)

b. For the SAE 4045 steel, plot the strain-life relationship. Given the following details:
σ_y' = 414 MPa, n' = 0.18, k' = 1344 MPa, σ_f' = 1227 MPa, ϵ_f' = 1.00, b = -0.095, c = -0.66, The Young's modulus of the material is 200 GPa.
Also, determine the expected number of loading cycles to fatigue, if the material is loaded at strain amplitude such that the elastic part of the strain amplitude equals the plastic part. **(10 Marks)**

5 a. Explain the following :
i) Effect of specimen thickness in fracture toughness and plane strain fracture toughness.
ii) Sigmoidal da/dN - ΔK curve. **(10 Marks)**

b. A SAE 1020 cold rolled thin plate is siubjected to constant amplitude uniaxial cyclic loads that produce normal stresses varying from S_{max} = 200 MPa to S_{min} = -50 MPa. The monotonic properties of this steel are:
S_y = 630 MPa , S_u = 670 MPa , E = 207 GPa , k_c = 104 MPa$\sqrt{m}$.
What fatigue life would be attained if an initial trough thickness edge crack existed and was 1 mm in length? Take A = 6.9×10^{-12} and n = 3. **(10 Marks)**

6 a. Explain the following : i) Normal and log normal distributions ii) Wesbull distribution as applied to interpretation of fatigue data. **(10 Marks)**

b. Fatigue strength, S_f, at 10^6 cycles versus Brinell hardness (HB) for seven grades of SAE 1141 steel are given as follows:

HB :	223	277	199	241	217	252	229
S_f(MPa) :	286	433	276	342	287	332	296

Using the linear regression, find the slope and intercept for these data. What fatigue strength corresponds to a Brinell hardness of 225? **(10 Marks)**

7 a. Enumerate the different cycle counting methods available and explain the rain-flow counting method, with an example. **(10 Marks)**

b. Explain the Macro-Starkey cumulative damage theory, used in the estimation of cumulative fatigue damage. **(10 Marks)**

8 a. Explain the meaning of surface fatigue, with examples. **(06 Marks)**

b. Derive an expression for the contact pressure distribution in a spherical contact. **(08 Marks)**

c. Explain the following :
i) Corrosion fatigue
ii) Fretting corrosion **(06 Marks)**

* * * * *