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12MMD/MDE22

# Second Semester M.Tech. Degree Examination, June / July 2014
## Advanced Machine Design

Time: 3 hrs. Max. Marks:100

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



1 a. Describe what is meant by 'synergistic failure mode'. Give three examples and for each example describe how synergistic action proceeds. **(08 Marks)**

b. A static force of 400 N is applied at point D near the end of a Cantilever beam OABC which is 375 mm long. This beam is made of cast iron Grade 30 with an ultimate strength in tension equal to 215 Mpa and ultimate strength in compression equal to 750 Mpa. The lever is machined to dimensions as shown. Determine the factor of safety using modified Mohr Theory. Neglect the effects of stress concentration. **(12 Marks)**

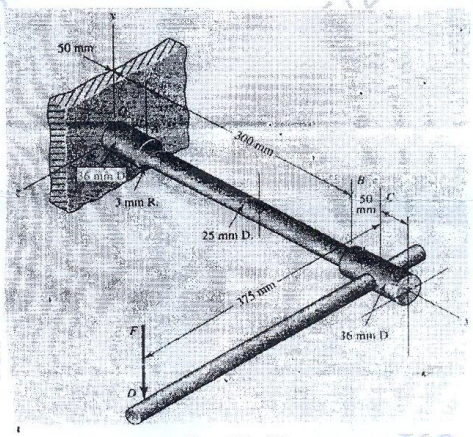


Fig. Q1 (b)

2 a. Explain the following:
i) Low cycle fatigue ii) High cycle fatigue. **(04 Marks)**

b. Explain the effect of the following on S-N behaviour:
i) Microstructure ii) Size effects iii) Surface finish iv) Frequency **(08 Marks)**

c. Explain the effect of 'Mean stress' on S-N behaviour. Also draw the constant life diagrams with superimposed yield criterion. **(08 Marks)**

3 a. A forged 50 mm diameter 1040 steel rod has $S_u = 689MPa$ and $S_y = 516MPa$. It is subjected to constant amplitude cyclic bending. Determine the following values using appropriate approximation models: i) Fully reversed fatigue strength at $10^6$ cycles .
ii) $S_a$ and $S_m$ for $10^6$ cycles if $R = 0$ iii) $S_a$ and $S_m$ for $10^4$ circles if $R = 0$. **(12 Marks)**

b. A machine component is subjected to a tensile stress in X-direction which varies from 40 to 100 Mpa. A tensile stress applied in Y-direction varies from 10 to 80 Mpa. Frequency of variation of these stresses is equal. The corrected value of endurance limit of the component is 270 Mpa. Ultimate tensile strength is 660 Mpa. Determine the factor of safety of this component under fatigue loading. **(08 Marks)**

4 a. Explain the following:
i) Cyclic hardening ii) Cyclic softening. **(04 Marks)**

b. Explain the concept of strain based approach to life estimation. **(06 Marks)**

c. Normalized 1141 steel has the following properties denoted by usual notations:

Su = 790 Mpa, E = 220 GPa, $\frac{Sy}{S'y} = \frac{493}{481}$ Mpa, $\frac{K}{K'} = \frac{1379}{1441}$MPa, $\frac{n}{n'} = \frac{0.187}{0.177}$, $\frac{\epsilon_f}{\epsilon'_f} = \frac{0.64}{0.602}$,

$\frac{\sigma_f}{\sigma'_f} = \frac{1117}{1326}$Mpa, b = -0.108, C = -0.581.

Determine the transition fatigue life; also determine the total strain amplitude by writing the general equation for the relation between life and strain amplitude at this transition fatigue life. **(10 Marks)**

5 a. Explain the following: i) Plane strain fracture toughness.
ii) Mean stress effects on fatigue crack growth behaviour. **(08 Marks)**

b. A very wide SAE 1020 cold rolled thin plate is subjected to constant amplitude uniaxial cyclic loads that produce nominal stresses varying from $S_{max} = 300MPa$ to $S_{min} = 100MPa$. The monotonic properties for this steel are Sy = 630MPa, Su = 670MPa, E = 207GPa and $K_C = 104\ MPa\sqrt{m}$. What fatigue life would be attained if an initial through thickness edge crack of 1 mm length existed in the plate? Take $A = 6.9 \times 10^{-12}$, n = 3 related to paris equation. Take $\lambda = 0.5$ in the Walker's relationship. **(12 Marks)**

6 a. Define the terms Notch, Notch sensitivity and fatigue notch factor. **(06 Marks)**

b. Explain the mean stress effects on notched part with the help of Heigh diagram. **(06 Marks)**

c. A notched member shown in Fig. Q6 (c) has a strain gage reading of 0.002 at the notch root. When a load of 40 kN is applied, Yielding for this material occurs at a strain of 0.0025. The load is increased such that the strain gage reads 0.0065 when the load is 80 kN. Determine $K_t$ and $K_\epsilon$. Compare it with values obtained using linear rule and Nueber rule. **(08 Marks)**

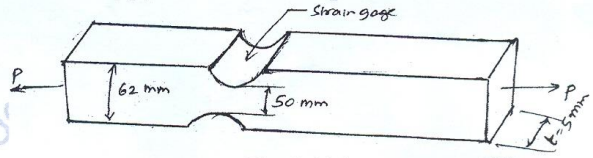


Fig. Q6 (c)

7 a. Explain the linear cumulative damage theory and discuss its limitations. **(05 Marks)**

b. With an example, explain the rain flow method of cycle counting. **(05 Marks)**

c. The work cycle of a mechanical component subjected to completely reveresed bending stresses consists of the following three elements:
i) $\pm 350\ N/mm^2$ for 85% of the time.
ii) $\pm 400\ N/mm^2$ for 12% of the time.
iii) $\pm 500\ N/mm^2$ for 3% of the time.
The material for the component is 50C4 with ultimate tensile strength of 660 Mpa and corrected endurance limit of 280 Mpa. Determine the life of the component using the linear damage theory. **(10 Marks)**

8 a. Explain the following: i) Adhesive wear. ii) Abrasive wear. **(10 Marks)**

b. Derive an expression for the contact pressure distribution in a parallel cylindrical contact. Show the distribution of pressure schematically. **(10 Marks)**

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12MMD/MDE/MEA23

# Second Semester M.Tech. Degree Examination, June/July 2014

## Dynamics and Mechanism Design

Time: 3 hrs. Max. Marks:100

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



1 a. Find the degrees of freedom of the chains shown in Fig.Q1(a). **(05 Marks)**

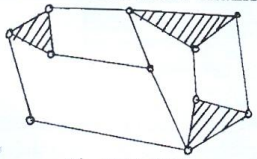

Fig.Q1(a)(i)

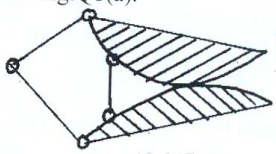

Fig.Q1(a)(ii)

b. Explain the Grashoff's law. Classify the four bar chain based on Grashoff's law. **(05 Marks)**

c. Find the equivalent mechanisms for the mechanisms shown in Fig.Q1(c). **(05 Marks)**

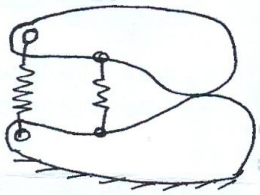

Fig.Q1(c)(i)

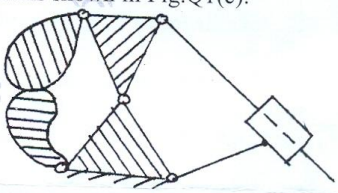

Fig.Q1(c)(ii)

d. Explain how velocity analysis can be carried out using auxiliary point method using rotated velocity vector (Hall-Ault) method. **(05 Marks)**

2 a. What are generalized coordinates? Give examples. **(05 Marks)**

b. Explain principle of virtual work. Give a suitable example. **(05 Marks)**

c. What are holonomic and nonholonomic constraints? Give example. **(10 Marks)**

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

b. A particle of mass m can slide without friction on the inside of a small tube which is bent in the form of a circle with radius 'r' as shown in Fig.Q3(b). The tube rotates about a vertical axis with a constant angular velocity ω. Write down the differential equation governing the motion. **(05 Marks)**

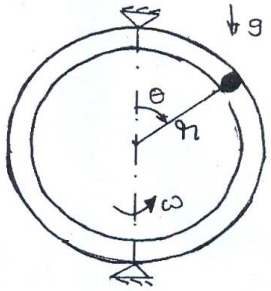


Fig.Q3(b)

c. Derive the Hamilton's equation. **(05 Marks)**

4 a. Derive the general differential equations of motion (Euler's equations). **(10 Marks)**

b. The natural time period of a spring-mass system is Tsec. It is subjected to a pulse as shown in Fig.Q4(b). Draw the phase-plane plot. **(10 Marks)**

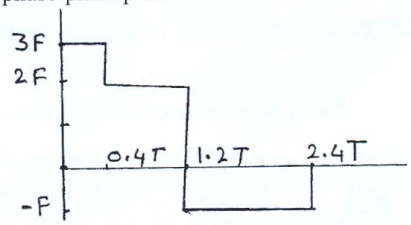


Fig.Q4(b)

5 a. Enumerate combination of a 8-link single degree of freedom chains. **(05 Marks)**

b. Sketch the (i) limit positions, (ii) dead center positions of a 4-bar chain. Identify the linkage. **(05 Marks)**

c. Explain how to synthesize a crank rocker mechanism with optimum transmission angle. **(05 Marks)**

d. Explain the terms fixed centrodes and moving centrodes. **(05 Marks)**

6 Synthesize a four bar linkage to generate the function $y = 1nx$ in the range $10 \leq x \leq 60$. Use four precession points. Range of input link is 120° and range of output link is 90°. Assume the length of input link s 27 mm. **(20 Marks)**

7 a. Obtain the Freudensteins equation to synthesize a four bar mechanism. **(10 Marks)**

b. Explain the Block's method and obtain the equations to synthesize a four bar mechanism. **(10 Marks)**

8 Write short notes on:

a. Position analysis **(05 Marks)**

b. Eulerian angles **(05 Marks)**

c. Goodman's indirect method for velocity and acceleration analysis. **(10 Marks)**

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12MMD/MDE24

# Second Semester M.Tech. Degree Examination, June/July 2014
## Advanced Theory of Vibrations

Time: 3 hrs. Max. Marks:100

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



1 a. A vibrating system is defined by the following parameters M = 3kg, K = 100 N/m, C = 3 N-sec/m. Determine: i) The damping factor; ii) The natural frequency of damped vibration; iii) Logarithmic decrement; iv) The ratio of two consecutive amplitudes and v) The number of cycles after which the original amplitude is reduced to 20 %. **(10 Marks)**

b. In Fig.Q.1(b) find the natural frequency of the system, if m = 10kg attached at one end of weightless rod and K = 1000 N/m. **(08 Marks)**

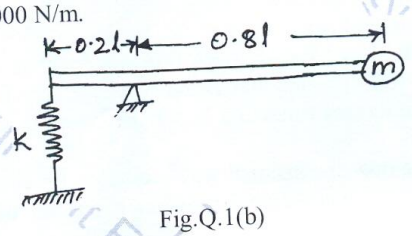


Fig.Q.1(b)

c. Define logarithmic decrement. **(02 Marks)**

2 a. Explain convolution integral. **(02 Marks)**

b. Use the convolution integral to determine the response of an undamped 1 degree-of-freedom system of natural frequency $W_n$ and mass 'm'. When subject to a constant force of magnitude $F_0$. The system is at rest in equilibrium at t = 0. **(08 Marks)**

c. Use the Lapalce transform method, to determine the response of an undamped 1 degree of freedom system of natural frequency '$W_n$' and mass 'm', when subject to a constant force of magnitude $F_0$. The system is at rest in equilibrium at t = 0. **(08 Marks)**

d. What is a shock-response spectrum (SRS)? Explain. **(02 Marks)**

3 a. A machine of mass 500kg is acted upon by an external force of 2000N at a frequency of 1500 rpm. To reduce the effect of vibration, an isolator of rubber having a static deflection of 2mm under machine load and an estimated damping factor G = 0.2 are used. Determine:
i) The force transmitted to the foundation. **(07 Marks)**
ii) The amplitude of vibration of machine. **(03 Marks)**

b. State the different methods, by which the vibration can be controlled.

c. A 200kg machine is attached to a spring of stiffness $4 \times 10^5$ N/m. During operation the machine is subjected to a harmonic excitation of magnitude 500N and frequency 50 rad/sec. Design an undamped vibration absorber such that the steady-state amplitude of the primary mass is zero and the steady-state amplitude of the absorber mass is less than 2mm. **(06 Marks)**

d. Write a note on the materials used for vibration isolation. **(04 Marks)**

4 a. Explain briefly the frequency measuring instruments. **(08 Marks)**

b. Briefly explain the importance of signal analysis. **(06 Marks)**

c. State the working principle of mechanical and electromagnetic exciters. **(06 Marks)**

5 a. Explain three types of maintenance schemes used in practice. **(07 Marks)**

b. Write a note on:

i) Experimental modal analysis.

ii) Vibration monitoring techniques. **(10 Marks)**

c. Mention several methods that are used to monitor the condition of a machine. **(03 Marks)**

6 a. Determine the phase plane of a single-DOF oscillator $\ddot{x} + w^2 x = 0$. **(06 Marks)**

b. Explain in detail about perturbation method. **(10 Marks)**

c. What is jump phenomenon? Explain. **(04 Marks)**

7 a. Explain the following terms:

i) Autocorrelation.

ii) Power spectrum and power spectral density.

iii) Ergodic process.

iv) Random time functions. **(10 Marks)**

b. A random signal has a spectral density that is a constant S(f) = 0.004 $cm^2$/cps between 20 and 1200 cps and that is zero outside this frequency range. Its mean value is 2.0cm. Determine its rms value and its standard deviation. **(10 Marks)**

8 a. Derive the one-dimensional wave equation for lateral vibrations of string. **(10 Marks)**

b. Derive the wave equation for torsional vibration of a uniform shaft. **(10 Marks)**

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12MMD/MDE252

# Second Semester M.Tech. Degree Examination, June / July 2014
## Theory of Plasticity

Time: 3 hrs. Max. Marks:100

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



1 a. Define octahedral stresses. Derive the expression for octahedral normal and shear stresses in terms of stress invariants. **(10 Marks)**

b. Show that deviatric stress invariants:

i) $I_1' = 0$

ii) $I_2' = \frac{1}{3}I_1^2 + I_2$

iii) $I_3' = \frac{1}{27}\left[27I_3 + 2I_1^3 + 9I_1I_2\right]$ **(10 Marks)**

2 a. Explain the cubical dilation and obtain its expression in terms of linear strains. **(08 Marks)**

b. The strain tensor at a point in a body is given by,

$$\varepsilon_{ij} = \begin{bmatrix} 0.0001 & 0.0002 & 0.0005 \\ 0.0002 & 0.0003 & 0.0004 \\ 0.0005 & 0.0004 & 0.0005 \end{bmatrix}$$

Determine

i) The octahedral normal and shearing strains.
ii) Deviatoric strain tensor.
iii) Spherical strain tensor. **(08 Marks)**

c. Explain representative stress and strain. **(04 Marks)**

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

b. A thin walled tube of mean radius 100 mm and wall thickness 4 mm is subjected to a mean torque of 10 N-m, if the yield strength of the tube material is 122.5 MPa. Determine the value of axial load P to be applied to the tube so that the tube starts yielding according to the VonMises yield criteria. **(10 Marks)**

4 a. Explain the experimental verification of Saint-Venant's theory of plastic flow. **(10 Marks)**

b. Explain the following :

i) Levy-Von-Mises equations.
ii) Concept of plastic potential. **(10 Marks)**

5 a. Derive the bending relationship for a material following non-linear stress-strain law in the form,

$$\frac{M}{I_n} = \frac{\sigma}{Y^n} = \frac{H}{R^n}$$ **(10 Marks)**

b. A circular shaft of radius 75 mm, is made of a non-linear material whose stress-strain curve is given by $\tau = 325\gamma^{0.4}$ if the shaft is required to transmit 90 kW at 200 rpm, determine the maximum shear stress induced in the shaft and the angle of twist per unit length. **(10 Marks)**

6 a. Obtain the expression for draw stress and zeroback pull stress, for a strip drawing considering friction. **(10 Marks)**

b. A strip with a cross section of 150mm × 6mm is being rolled with 20% reduction of area using 400 mm diameter steel rolls. Calculate

i) The final strip thickness.

ii) The angle subtended by the deformation zone at the roll centre, and

iii) The location of the neutral plane. Assume coefficient of friction to be 0.1. **(10 Marks)**

7 a. Derive Geiringer's continuity equations. **(10 Marks)**

b. State and prove Hencky's first theorem. **(10 Marks)**

8 Write short notes on:

a. Upper bound theorem.

b. Hodo graphs.

c. Forging defects.

d. Saap film analogy for plastic torsion. **(20 Marks)**

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