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12MMD/MDE22

# Second Semester M.Tech. Degree Examination, Dec.2014/Jan.2015
## Advanced Machine Design

Time: 3 hrs. Max. Marks:100

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



1 a. State and explain distortion energy theory. Derive the expression for the failure criterion for the same. **(10 Marks)**

b. Determine the factor of safety for the bracket rod shown in Fig.Q1(b) based on both distortion energy theory and maximum shear stress theory and compare them. The material is 2024 - $T_4$ aluminium with a yield strength of 330 MPa. The rod length of $l$ is 15 cm and arm a = 20 cm. The rod outside diameter d = 3.5 cm, and load F = 4500 N. Assume the load is static and assembly is at room temperature. Neglect shear due to transverse loading.

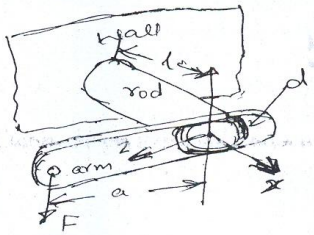


Fig.Q1(b) **(10 Marks)**

2 a. Discuss on the difference between the safe-life design and fail-safe design. **(08 Marks)**

b. Explain the following :
(i) Design to code (ii) High cycle and low cycle fatigue. **(04 Marks)**

c. With a schematic, explain the typical stages of the fatigue damage process. **(08 Marks)**

3 a. Discuss in detail the effect of mean stress on S-N behavior. **(07 Marks)**

b. A 2024 - $T_3$ aluminium alloy smooth bar has a diameter of 15 mm and is subjected to axial stresses. Determine the following using reasonable approximate fatigue models:
i) Fully reversed fatigue strength at $5\times10^8$ cycles and
ii) $S_{max}$, $S_{min}$, $S_a$ and $S_m$ for fatigue strength at $5\times10^8$ cycles with R = – 0.2.
iii) Repeat part ii) for $10^5$ cycles. **(13 Marks)**

4 a. Explain the following :
i) Bauschinger effect ii) Cyclic softening iii) Cyclic hardening iv) transition fatigue life. **(12 Marks)**

b. Determine the transition fatigue life, $2N_t$ for normalized 1038 steel alloy, and also total strain amplitude at this life for this alloy. **(08 Marks)**

5 a. With a neat sketch discuss the effect of temperature and specimen thickness on fracture toughness. **(08 Marks)**

b. A wide SAE 1020 cold-rolled thin plate is subjected to constant amplitude uniaxial cyclic loads that produce nominal stresses varying from $S_{max}$ = 200 MPa to $S_{min}$ = –50 MPa. The monotonic properties for this steel are $S_y$ = 630 MPa, $S_u$ = 670 MPa, E = 207 GPa and $K_c = 104\ \text{MPa}\sqrt{\text{m}}$. What fatigue life would be attained if an initial through thickness edge crack existed and was 1 mm in length? Take $A = 6.9\times10^{-12}$ m/cycle and n = 3. **(12 Marks)**

6 a. Calculate the fatigue notch factor $K_f$ using Peterson's formula for a 25 mm hole and for a 1 mm hole in mild steel with $S_u$ = 350 MPa and in hard steel width $S_u$ = 1750 MPa. In all cases $K_t$ = 2.5. **(05 Marks)**

b. Explain Glinka's rule with the help of graphical representation. **(08 Marks)**

c. Show a schematic depicting Haigh diagram for 7075 - $T_6$ aluminium alloy at 1 million cycles with and without a notch. **(07 Marks)**

7 a. Explain Palmgren-Miner linear damage rule and compare with nonlinear damage theories. **(10 Marks)**

b. Explain (i) Rain flow and (ii) Range-pair cycle counting methods. **(10 Marks)**

8 a. Write short notes on :
i) Adhesive wear ii) Abrasive wear iii) Corrosion wear iv) Fretting wear. **(10 Marks)**

b. A ball thrust bearing with 7 balls is loaded axially across its races through the balls. What is the size of the contact patch on a race and what are the stresses developed in the balls and races. What is the maximum depth at which shear stress is maximum in a ball. The 7 spherical balls are 10 mm in diameter and the races are flat. All parts are made of hardened steel. The axial load is 665 N and assume that the 7 balls share load equally. The rotation speed is sufficiently slow that this can be considered a static loading problem. **(10 Marks)**

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12MMD/MDE/MEA23

# Second Semester M.Tech. Degree Examination, Dec.2014/Jan.2015
## Dynamics and Mechanism Design

Time: 3 hrs. Max. Marks:100

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



1 a. Explain briefly planar, spherical and spatial mechanism. **(06 Marks)**
b. State Grashoff's law. What are the mechanisms derived from its inversion. **(08 Marks)**
c. Find mobility of the mechanism shown in Fig. Q1(c)(i),(ii). **(06 Marks)**

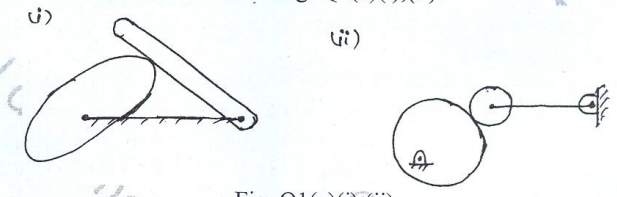


Fig. Q1(a)(i),(ii)

2 a. What are constraints? Explain different types of constraints. **(06 Marks)**
b. Explain the virtual displacement, virtual work and principle of virtual work. **(06 Marks)**
c. A particle of mass 'm' is embedded at a distance $\ell$ from the centre of a massless circular disc of radius 'r', it rolls without slipping down a plane inclined at an angle '$\alpha$' with the horizontal. Find the equation of motion. **(08 Marks)**

3 a. Derive Lagarange's equation from D'Alembers principle. **(10 Marks)**
b. Derive Hamilton's equation for holonomic system. **(10 Marks)**

4 a. Derive the Euler's equation of motion. **(05 Marks)**
b. Write phase plane diagram and displacement diagram of vibrating system as shown in Fig.4(b). **(05 Marks)**

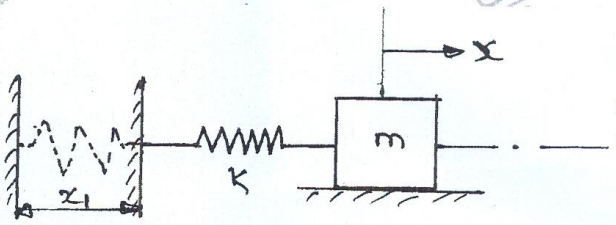


Fig. Q4(b)

c. Measurement on mechanical vibrating system mass of 7.67 kg and spring index of 544.8 kg/m. A transient force resembling the first half-cycle of a sine wave operates on the system. If the maximum value of the force is 4.54 kg determine the response when the force is applied for 0.120s. Assume an undamped vibration. **(10 Marks)**

5 a. Explain in brief : i) Dimensional synthesis ii) pole iii) structural error
iv) precession position v) inflection circle. **(10 Marks)**
b. Explain with the help of sketch, how the slider crank mechanism can be synthesized for two given positions. **(10 Marks)**

6 a. Write note on :
i) Over lay method
ii) Coupler – curve synthesis **(10 Marks)**

b. The rocker of a crank – rocker linkage is to have a length of 500 mm and swing through a total angle of 45° with a time ratio of 1.25. Determine a suitable length of remaining links. **(10 Marks)**

7 a. A 4 – bar linkage is required to generate a function $y = x^{1.6}$ for $1 \leq x \leq 3$. The input link rotates from 60° to 120° and follower link rotes 60° to 150° using three accuracy points of Chebychev find $\psi_1, \psi_2, \psi_3$ and $\phi_1, \phi_2, \phi_3$. where $\phi_i$ is output angle, $\psi_i$, is input angle. **(10 Marks)**

b. Synthesize a 4 – bar linkage to give the following values for the angular velocities and accelerations :

$\omega_2 = -3$ rad /sec $\quad \alpha_2 = 0$ rad/sec$^2$
$\omega_3 = 2$ rad/sec $\quad \alpha_3 = 16$ rad/sec$^2$
$\omega_4 = 3$ rad/s $\quad \alpha_4 = 8$ rad/sec$^2$

**(10 Marks)**

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

b. The angular velocity of link 2 of 4 – link RGGR linkage of Fig. Q8(b) is $\omega_2 = 40\ \hat{k}$ rad/s and is constant. Find the position of all moving links. Using analytical method. **(10 Marks)**

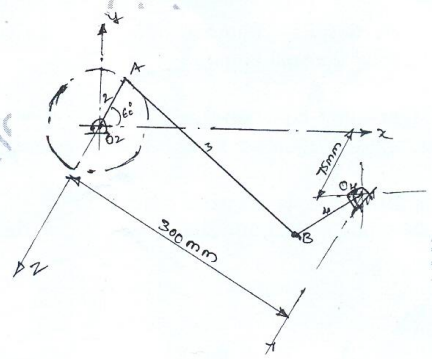


Fig. Q8 (b)

$R_{AO_2} = 100\text{mm}$, $R_{BA} = 375\text{mm}$, $R_{BO_4} = 250\text{mm}$

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12MMD/MDE24

# Second Semester M.Tech. Degree Examination, Dec.2014/Jan.2015
## Advanced Theory of Vibration

Time: 3 hrs. Max. Marks:100

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



1 a. Determine the natural frequency of the system shown in Fig.Q.1(a) using energy method. **(10 Marks)**

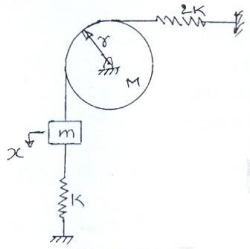


Fig.Q.1(a)

b. A block of mass moves on a horizontal friction less surface as shown in Fig.Q.1(b). i) Derive the equation of motion; ii) Find the time period of oscillation; iii) for what value of C is the system critically damped?; iv) find the response of the system when it is released with the initial conditions x(0) = 0 and $\dot{x}(0)$ =5m/s. If m = 2kg, k = 48N/m, c = 4 N-s/m. **(10 Marks)**

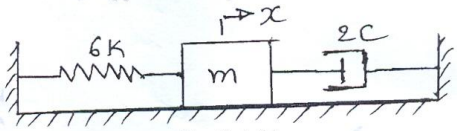


Fig.Q.1(b)

2 a. A trailer being pulled at a speed (high) shown in Fig.Q.2(a), hits a h cm high curb. Considering the trailer to be a single degree freedom spring-mass system, analyze the system for its response to a step input. **(08 Marks)**

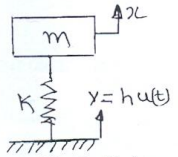


Fig.Q.2(a)

b. Find the Laplace transform of a pulse of height A and duration τ as shown in Fig.Q.2(b). Deduce the Lapalce transform of a unit impulse. **(12 Marks)**

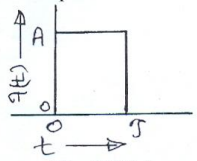


Fig.Q.2(b)

3 a. What is dynamic vibration absorber? Show that, for such a absorber, natural frequency should be equal to the applied frequency. **(12 Marks)**

b. A 50kg mass is attached to a base through a spring and dashpot as shown Fig.Q.3(b). The base undergoes a harmonic excitation of y = 0.2sin 30t. The spring has stiffness value of $3 \times 10^4$ N/m and dashpot constant is 200 N-s/m. Find out: i) relative displacement of the mass and ii) Absolute displacement of mass. **(08 Marks)**

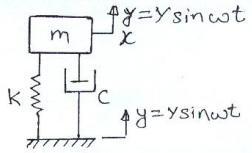


Fig.Q.3(b)

4 a. Classify the vibration transducers. **(04 Marks)**

b. Explain with schematic sketch, the working principle of: i) Piezoelectric transducer; ii) Electro dynamic shaker. **(10 Marks)**

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

5 a. Explain briefly machine condition monitoring techniques and machine vibration monitoring techniques. **(10 Marks)**

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

6 a. For the system shown in Fig.Q.6(a), find the time period (system with an abrupt non-linearity in spring) per cycle as a function of amplitude of vibration. **(12 Marks)**

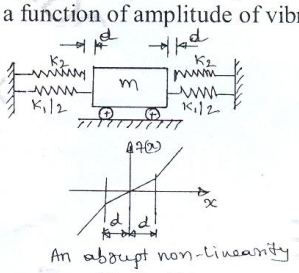


Fig.Q.6(a)

b. For the system of non-linear vibrations represented by the differential equation: $m\ddot{x} + x + \beta x^3 = 0$. Obtain a plot of the time period against amplitude of vibration when i) $\beta$ = + 1/3 (hard spring); ii) $\beta$ = -1/3 (soft spring). **(08 Marks)**

7 a. Define the following terms: i) White noise; ii) Wide-band process; iii) Narrow band process; iv) Ergodic process. **(10 Marks)**

b. What are the characteristics of auto correlation function of a stationary random process? **(10 Marks)**

8 Uniform string of length *l*, fixed at both ends is pulled laterally by a distance h at its mid point as shown in Fig.Q.8 and then released. Determine the equation of motion for the string. **(20 Marks)**

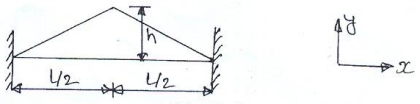


Fig.Q.8

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12MMD/MDE252

# Second Semester M.Tech. Degree Examination, Dec.2014/Jan.2015
## Theory of Plasticity

Time: 3 hrs. Max. Marks:100

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



1 a. Define the following:
i) Representative strain.
ii) Hydrostatic and deviatoric stresses
iii) Complementary shear stresses.
iv) Octahedral stresses
v) Cubical dilation **(10 Marks)**

b. The stress tensor at a point is given by,

$$\tau_{ij} = \begin{bmatrix} 50 & 50 & 150 \\ 50 & 100 & 100 \\ 150 & 100 & 150 \end{bmatrix} N/mm^2$$

Calculate for the plane having direction cosines,

$$a_{nx} = \frac{1}{\sqrt{6}},\ a_{ny} = \frac{1}{\sqrt{3}},\ a_{nz} = \frac{1}{\sqrt{2}}$$

i) total stresses ii) normal stress and iii) Shear stress and its direction. **(10 Marks)**

2 a. What do you understand by a yield criterion? Explain the two yield criteria commonly used. **(06 Marks)**

b. The state of stress at a point is given by $\sigma_x = 70$ MPa, $\sigma_y = 120$ MPa, $\tau_{xy} = 35$ MPa. If the yield strength for the material is 125 MPa, determined in a uniaxial tensile test, whether yielding will occur according to Tresca's and Van-Mises yield conditions or not. **(08 Marks)**

c. Explain Lode's stress experiment of yield criteria. **(06 Marks)**

3 a. Enumerate the various types of materials encountered in practice from plastic flow point of view. Also sketch the corresponding mechanical models. **(10 Marks)**

b. Explain the Prandtl-Reuss equation to determine the stress-strain relation for an elastic perfectly plastic material. **(10 Marks)**

4 a. Explain factors affecting plastic deformation. **(10 Marks)**

b. What is pie-plane? How the yield criteria can be represented on the pie-plane ($\pi$ - plane). **(10 Marks)**

5 a. Explain isotropic hardening. **(10 Marks)**

b. Explain upper and lower bound theorems. **(10 Marks)**

6 a. A rectangular beam 80 mm wide and 100 mm deep is 2 m long and is simply supported at the ends. The yield strength for the beam material is 250 MPa. Determine the value of the concentrated load applied at the beam midspan if (i) the outermost fibres of the beam just start yielding (ii) the outer shell upto 20 mm depth yields and (iii) whole of the beam yields. Assume linear stress-strain idealized curve for the beam material. **(10 Marks)**

6 b. A solid circular shaft of radius 120 mm is subjected to transmit 600 kW at 540 rpm. The maximum torque is 30 percent greater than the mean torque. If the shear stress shear strain curve for the shaft material is given by, $\tau = 280\gamma^{0.25}$, determine the maximum stress induced in the shaft and the corresponding angle of twist. What would be these values if the stress-shear strain curve is a linear one? $G = 0.84 \times 10^5$ N/mm$^2$. **(10 Marks)**

7 a. Determine the forces on rolling during,
i) Simple rolling process
ii) Rolling with front and back tensions.
iii) Rolling with one driven roll. **(12 Marks)**

b. A strip of steel 20 mm wide and 5 mm thick is drawn through frictionless dies to the final size of 15 mm wide and 5 mm thick. If the yield stress for the strip material is 175 N/mm$^2$, determine the stresses in the strip at the exit of the dies and the reduction. **(08 Marks)**

8 a. List the properties of slip-line field theory. **(08 Marks)**

b. Sketch and explain continuity equations of slip line field theory. **(12 Marks)**

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