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14MDE21

Second Semester M.Tech. Degree Examination, June/July 2016

Composite Materials Technology

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions.***
2. ***Use of data handbook is permitted.***

1 a. Define composite material. Explain the role of matrix and reinforcement in composite material. **(06 Marks)**

b. Write short notes on following composites with neat sketches:
i) Particulate composites
ii) Laminate composites
iii) Sandwich composites **(10 Marks)**

c. What are the applications of MMC's? **(04 Marks)**

2 a. Write stiffness matrix for following materials with number of independent elastic constants:
i) Anisotropic material
ii) Monoclinic material
iii) Orthotropic material
iv) Isotropic material **(10 Marks)**

b. For a graphite/epoxy unidirectional lamina, find the following:
i) Compliance matrix
ii) Minor Poisson's ratio
iii) Reduced stiffness matrix
iv) Strains in coordinate system
Given: $\sigma_1 = 2$ MPa, $\sigma_2 = -3$ MPa, $\sigma_3 = 4$ MPa, $E_1 = 181$ GPa, $E_2 = 10.3$ GPa, $\gamma_{12} = 0.28$, $G_{12} = 7.17$ GPa. **(10 Marks)**

3 a. Derive stress-strain relations for a lamina of arbitrary orientation. **(10 Marks)**

b. Find the maximum value of $s > 0$ if a stress of $\sigma_x = 2s$, $\sigma_y = -3s$ and $\tau_{xy} = 4s$ is applied to a 60° graphite/epoxy lamina. Use maximum stress failure theory and Tsai-Hill failure theory. Given $\sigma_1 = 1.714s$, $\sigma_2 = -2.714s$, $\tau_{12} = -4.165s$, $(\sigma_1^T)_{ult} = 1500$ MPa, $(\sigma_1^c)_{ult} = 1500$ MPa, $(\sigma_2^T)_{ult} = 40$ MPa, $(\sigma_2^c)_{ult} = 246$ MPa, $(\tau_{12})_{ult} = 68$ MPa. **(10 Marks)**

4 a. Determine the modulus of elasticity of a FRP on the fiber direction (E_1) and in the transverse direction (E_2) with proper representative sketches. **(12 Marks)**

b. A unidirectional glass/epoxy lamina with a fiber volume fraction of 70% is replaced by a graphite/epoxy lamina with the same longitudinal Young's modulus. Find the fiber volume fraction required in the graphite/epoxy lamina. Given $E_{glass} = 85$ GPa, $E_{Graphite} = 230$ GPa, $E_{Epoxy} = 3.4$ GPa. **(08 Marks)**

5 a. List the assumptions of classical laminate theory (CLT). Derive [A], [B] and [D] matrices for the laminate. **(14 Marks)**

b. Write the laminate codes for the following:
i) Symmetric laminate
ii) Cross-ply laminate
iii) Balanced laminate **(06 Marks)**

6 a. Discuss the following:
   i) Laminate design for strength
   ii) Laminate design for stiffness. **(10 Marks)**

b. Find the three stiffness matrices [A], [B] and [D] for a three ply [0/30/-45] graphite/epoxy laminate as shown in Fig.Q6(b). Assume each lamina has a thickness of 5 mm.

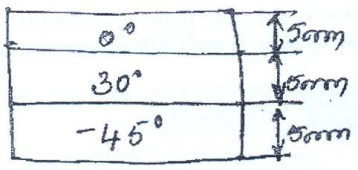

Fig.Q6(b)

Take: $[\bar{Q}]_0 = \begin{bmatrix} 181.8 & 2.897 & 0 \\ 2.897 & 10.35 & 0 \\ 0 & 0 & 7.17 \end{bmatrix}$ GPa

$[\bar{Q}]_{30^\circ} = \begin{bmatrix} 109.4 & 32.46 & 54.19 \\ 32.46 & 23.65 & 20.05 \\ 54.19 & 20.05 & 36.74 \end{bmatrix}$ GPa

$[\bar{Q}]_{-45^\circ} = \begin{bmatrix} 56.66 & 42.32 & -42.87 \\ 42.32 & 56.66 & -42.87 \\ -42.87 & -42.87 & 46.59 \end{bmatrix}$ GPa

(16 Marks)

7 a. With the help of a neat sketch, explain filament winding process. **(10 Marks)**

b. Explain with neat sketch, vacuum bag moulding process. **(10 Marks)**

8 Write short notes on any FOUR:

a. Application of composite in automobile
b. Application of composite in aerospace
c. Defects in composites
d. Water jet cutting of composites
e. Joining of composites. **(20 Marks)**

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14MDE22

Second Semester M.Tech. Degree Examination, June/July 2016
Advanced Machine Design

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions.***
2. ***Use of design data book is permitted.***

1 a. Discuss the role of failure prevention analysis in mechanical design. **(03 Marks)**

b. Determine the factors of safety at critical points in the brake lever shown in Fig. Q1 (b). The material of the brake lever is die-cast aluminium alloy ASTM G8A with $S_{ut} = 310$ MPa and $S_y = 186$ MPa. The elongation to fracture is 8%, making it a marginally ductile material. The average human's hand can develop a grip force of about 267 N in the lever position shown. **(17 Marks)**

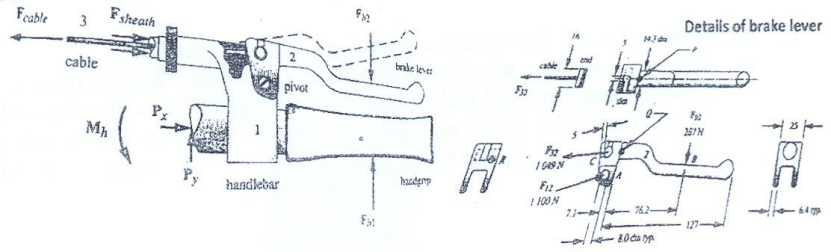

Fig.Q1 (b)

2 a. Discuss the following design criteria with examples, (i) Fail safe design (ii) Damage-tolerant design. **(06 Marks)**

b. With the help of a schematic diagram of a computer-controlled closed loop fatigue testing machine, explain the procedure to develop an S-N-P plot in the fatigue laboratory by standard methods. **(14 Marks)**

3 a. Discuss the effect of mean stress and microstructure on S-N behavior. **(08 Marks)**

b. Estimate the number of cycles a home light switch must endure during its expected life time. Assume 6 operations per day and 50 years of expected life time. **(02 Marks)**

c. A smooth uniaxial rod with a cross sectional area of 1150 mm^2 is made from a material with $S_f = 300$ MPa under R = -1 conditions, $S_u = 650$ MPa and $\sigma_f = 700$ MPa. If the rod is subjected to a mean force of 180 kN, what is the allowable alternating force that will not cause failure in 10^6 cycles according to the Morrow criterion? Repeat the calculation using Goodman criterion. **(10 Marks)**

4 a. With the help of stress-strain diagram describe engineering and true stress-strain behavior. **(04 Marks)**

b. Sketch monotonic and cyclic stress-strain curves for 2024-T4 aluminum and SAE4340 steel. **(04 Marks)**

c. Describe strain-based (ϵ-N) approach to life estimation. **(08 Marks)**

d. Discuss the effect of surface finish on strain life behavior. **(04 Marks)**

5 a. Describe in detail the effect of specimen thickness on fracture toughness. **(05 Marks)**

b. With reference to low alloy nuclear pressure vessel steel A533B, explain how fracture toughness K_{IC} is dependent on temperature. **(05 Marks)**

c. A very wide SAE 1020 cold rolled thin plate is subjected to constant amplitude uniaxial cyclic loads that produce nominal stresses varying from $S_{max} = 200$ 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 $K_C = 104 \text{ MPa}\sqrt{m}$. What fatigue life would be attained if an initial through – thickness edge crack existed and was 5 mm in length? Take $A = 6.9 \times 10^{-12}$ m/cycle and n = 3. **(10 Marks)**

6 a. Discuss mean stress effects and Haigh diagram for 7075 – T6 wrought aluminum alloy. **(10 Marks)**

b. Explain Glinka's rule applied to notch stress – strain analysis. **(10 Marks)**

7 a. Explain Palmgren-Minern linear damage rule applied for prediction of ball bearing life. **(10 Marks)**

b. Discuss on the rainflow cycle counting method. **(10 Marks)**

8 a. Write notes on : (i) Adhesive wear and (ii) Corrosion wear. **(10 Marks)**

b. An overhead crane wheel runs slowly on a steel rail. What is the size of the contact patch between wheel and rail and what are the stresses? What is the depth of the maximum shear stress? The wheel is 250 mm diameter and 20 mm thick and the rail is flat. Both parts are steel, the radial load is 18000 N, Poisson's ratio is 0.28, and $E = 2.1 \times 10^5$ N/mm^2. **(10 Marks)**

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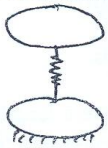
14MDE23

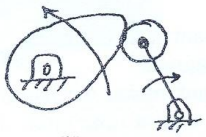
Second Semester M.Tech. Degree Examination, June/July 2016
Dynamics and Mechanism Design

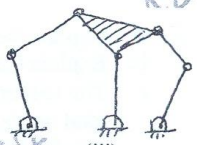
Time: 3 hrs. Max. Marks: 100

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

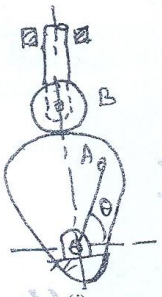
1 a. Find degree of freedom of each of following: **(06 Marks)**


(i)

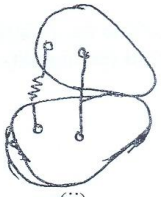

(ii)


(iii)

b. For the linkages shown below determine the equivalent linkages and compute d.a.f. for both configurations. **(08 Marks)**



(i)


(ii)

c. Define transmission angle and deviation angle for a four bar mechanism and what are their optimum values and what is mechanical advantage. **(06 Marks)**

2 a. State principle of virtual work. **(02 Marks)**

b. Explain types of constraints with examples. **(08 Marks)**

c. Consider a particle which is constrained to move on a fixed circular path of radius "a". Obtain transformation from Cartesian coordinate to generalized coordinates. The equation of constraint is $\left(x_1^2 + x_2^2\right)^{1/2} = a$. **(10 Marks)**

3 a. Derive Lagrange equation in principle form for a system of N-particles. **(10 Marks)**

b. A double pendulum consists of two particles suspended by massless rods as shown in figure below.

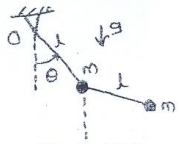


Fig.Q.3(b)

Assume that all motions take place in a vertical plane. Find differential equations of motion using Lagrangian. **(10 Marks)**

4 a. Deduce the condition for free precession of gyroscope with steady precession. **(10 Marks)**

b. Obtain the phase plane response of a single degree freedom of a spring mass system with K = 100000 N/m (100 N/mm) mass, m = 50 kg subjected to excitation as shown below. **(10 Marks)**

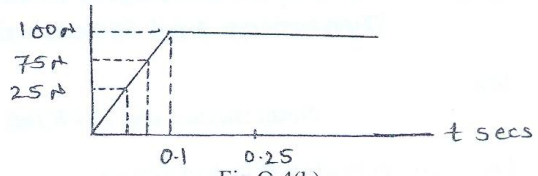


Fig.Q.4(b)

5 a. Explain the important tasks of kinematic synthesis. **(06 Marks)**

b. Explain Caley's diagram. **(04 Marks)**

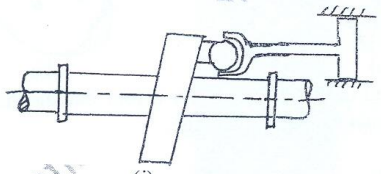
c. The rocker of a crank rocker mechanism is to have a length of 50mm and swings through a total angle of 45° with a time ratio of 1.25. Synthesize the mechanism, to determine the suitable set of dimensions. **(10 Marks)**

6 a. Explain overlay method of synthesis. **(06 Marks)**

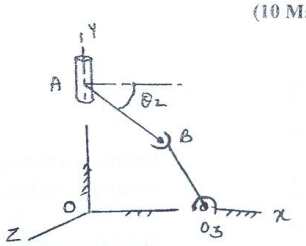
b. Synthesize a function generator to generate a function $y = \log_{10}x$ in the interval $1 \leq x \leq 10$. The input crank is 50mm length. The input crank is to rotate from 45° to 105° while the output crank moves from 135° to 225°. Use Freudeinstein's equation. **(14 Marks)**

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

b. Find the mobility of following mechanisms: **(10 Marks)**



(i)



(ii)

8 Write short notes on any four:

a. Grashoff's law

b. Goodman's indirect method of velocity

c. Hamilton principle, Hamilton equation

d. Poles and relative poles

e. Point position reduction

f. Bloach method of synthesis. **(20 Marks)**

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14MDE24

Second Semester M.Tech. Degree Examination, June/July 2016
Advanced Theory of Vibrations

Time: 3 hrs. Max. Marks:100

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

1 a. A cylinder of radius 'r' rolls without slipping of a cylindrical surface of radius 'R' as shown in Fig. Q1(a). Derive the equation for natural frequency of small oscillations about the lowest point. Use energy method. **(08 Marks)**

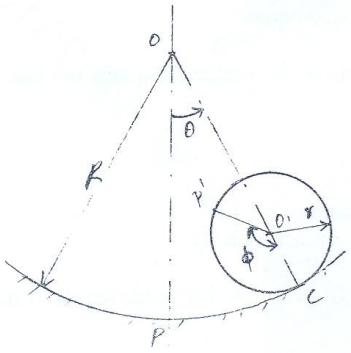

Fig. Q1(a)

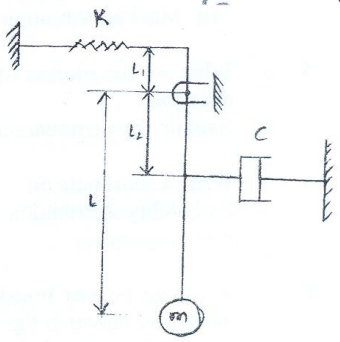

Fig. Q1(b)

b. A simple Pendulum is pivoted at point 'O' as shown in Fig. Q1(b). Assuming small oscillations and neglecting the mass of rod, find the damped natural frequency of pendulum. **(08 Marks)**

c. A vibrating system having mass 1kg is suspended by a spring of stiffness 1000N/m and it is put to harmonic excitation of 10N. Assuming viscous damping, determine
   i) Resonant frequency
   ii) The phase angle at resonance
   iii) The amplitude at resonance
   iv) The frequency corresponding to the peak amplitude and
   v) Damped frequency

   Take C = 40 N-S/m **(04 Marks)**

2 a. A spring – mass system is shown in Fig Q2(a). if the system is initially relaxed and a step function excitation is applied to the mass, find the response of the system. **(10 Marks)**

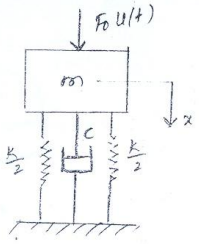

Fig. Q2(a)

b. What do you by shock isolation and derive an expression for force transmitted to the foundation due to the spring and damper is given in shock isolation. **(10 Marks)**

3 a. What is dynamic vibration absorber? Show that for such an observer, the natural frequency should be equal to the applied frequency. **(10 Marks)**

b. Explain the principle of "Seismic" instrument and indicate how it can be used to measure displacement and acceleration of vibrating body. **(10 Marks)**

4 a. Explain experimental modal analysis covering the required hardware. **(10 Marks)**

b. Write a short note on :

i) Machine condition monitoring techniques

ii) Machine vibration monitoring techniques. **(10 Marks)**

5 a. What are the sources of Non-linearity in the system? Explain any two non-linearity with an example. **(10 Marks)**

b. Explain the perturbation method. **(10 Marks)**

6 Write a short note on

a. Probability distribution b. Correlation

c. Power spectrum d. Power spectral density. **(20 Marks)**

7 What are Fourier transforms and Determine the harmonic series of the following periodic motion as shown in Fig. Q7 **(20 Marks)**

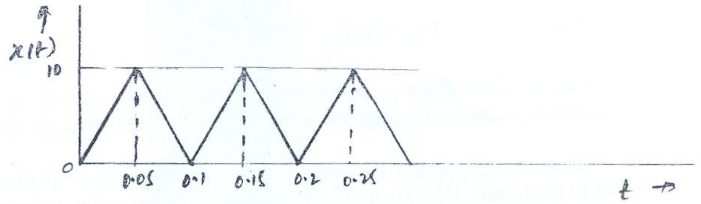

Fig. Q7

8 a. Obtain an expression for general solution of vibration of string. The tension 'T' is large and amplitude of vibration is small. **(10 Marks)**

b. A rod carries a disc at its lower end as shown in Fig. Q8 (b). Derive the expression for the natural frequencies. **(10 Marks)**

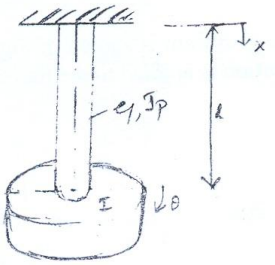

Fig. Q8(b)

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14MDE252

Second Semester M.Tech. Degree Examination, June/July 2016
Theory of Plasticity

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions.***
2. ***Assume any missing data.***

1 a. Define the following :
i) Octahedral stress ii) Representative stress iii) True stress and True strain. **(06 Marks)**

b. The state of stress at a print is given by the following stress tensor

$$[\sigma_{ij}] = \begin{bmatrix} 50 & 50 & -40 \\ 50 & -30 & 30 \\ -40 & 30 & -100 \end{bmatrix} \text{MPa}$$

Determine :
i) Principal stress and directions of maximum principal stress,
ii) Octahedral stress
iii) Representative stress and
iv) Spherical and Deviator stress Tensor. **(14 Marks)**

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

b. What do you understand by yield criteria? Explain the two yield criteria's commonly used. **(10 Marks)**

3 a. Explain yield criterion for an anisotropic material. **(10 Marks)**

b. The metal body 'S' in the plstic state under the action of following stress.

$$[\sigma_{ij}] = \begin{bmatrix} 120 & 60 & 40 \\ 60 & -100 & 30 \\ 40 & 30 & 80 \end{bmatrix} \text{MPa}$$

If a von-mises yield criterion is used to predict the onset of plastic yielding, what would be the yield strength of the material in the tension and shear. **(10 Marks)**

4 a. Explain the saint Venant's theory of plastic flow in detail, what are the limitations of this theory? **(10 Marks)**

b. Explain briefly the experimental verification Prandtl-Rauss equations. **(10 Marks)**

5 a. A beam of reactgular cross section 40mm wide 60mm deep is 4m in length and is simply supported at the ends. It carries a uniformly distributed load of intensity 'w' N/m over whole length of the span, If the yield strength of the beam material is 240MPa, calculate the value of load 'w' when,
i) The beam is to yield at the outermost fibers and
ii) The outer 10mm shell is to yield. **(10 Marks)**

b. A hollow shaft having inner radius 'r_i' outer radius 'r_2' is subjected to torque. Force elastic perfectly material obtain the expression for torque required to cause i) Incipient yielding ii) Elasto-plastic yielding and iii) Full plastic yielding. **(10 Marks)**

6 a. A strip of initial width 6.25mm is drawn through tapered dies to a final width of 5.625mm in a state of plane strain, considering thickness to be equal to 10mm, semi die angle 10° co-efficient of friction 0.03, determine the draw stress when i) Back pull is zero and ii) Back pull's 150N yield stress for strip material is 250Mpa. **(10 Marks)**

b. An aluminum rod 6.25mm diameter is drawn into wire 5.60mm diameter, Neglecting friction between rod and the dies, determine the drawing stress and reduction in area when yield stress for Aluminum is $35N/mm^2$. Also calculate the tangential stress at the exits. **(10 Marks)**

7 a. What is the significance of slip line field theory? List the assumptions made in this theory. **(08 Marks)**

b. Define the Geiringer's continuity equations. **(12 Marks)**

8 Write short note on any four of the following :

a. Upper Bound Theorem
b. Plstic potential
c. Isotropic Hardening
d. Levy Load variables
e. Haigh – westergard stress space. **(20 Marks)**

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