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10MMD/MDE21

Second Semester M.Tech. Degree Examination, June 2012

Composite Materials Technology

Time: 3 hrs. Max. Marks:100

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

1 a. What are the advantages and drawbacks of a composite material? **(06 Marks)**

b. Explain with a schematic sketch, the manufacturing of glass fiber. **(08 Marks)**

c. What are prepregs? Give a schematic of prepreg manufacturing. **(06 Marks)**

2 a. Write down the stress – strain relationships for unidirectional and Angle Lamina under two – dimensional loading and differentiate between these two relationships. **(06 Marks)**

b. Find the engineering constants of a 60^0 graphite/epoxy lamina.
Given E_1 = 181 GPa , E_2 = 10.3 GPa , γ_{12} = 0.28 , G_{12} = 7.17 GPa for unidirectional lamina. **(14 Marks)**

3 a. Derive rule of mixture for in – plane shear modulus of a lamina. State the assumptions made in the derivation. Also sketch the variation of in-plane shear modulus with fiber – volume fraction. **(12 Marks)**

b. The longitudinal modulus of a glass reinforced plastic lamina is to be doubled by substituting some of the glass fibers with carbon fibers. The total fiber volume fraction remains unchanged at 0.5. Calculate the carbon fiber volume fraction.
Take E_c = 300 GPa, E_g = 70GPa, E_m = 5 GPa. **(08 Marks)**

4 a. An angle lamina made of S – glass/epoxy has the following properties in the principal fiber direction. $(\sigma_1^T)_{ult}$ = 1280 MPa , $(\tau_{12})_{ult}$ = 69 MPa , $(\sigma_1^c)_{ult}$ = 622MPa , $(\sigma_2^T)_{ult}$ = 49MPa , $(\sigma_2^c)_{ult}$ = 245MPa. E_1 = 35 GPa , E_2 = 7 GPa , γ_{12} = 0.3 , G_{12} = 3 GPa. A tensile load of σ_x = 2 MPa is applied at an angle 60^0 to the principal fiber direction. Check the safety of the laminate as per i) Maximum stress theory ii) Maximum strain theory. **(15 Marks)**

b. Write a note on modified Tsai – Hill Failure Theory. **(05 Marks)**

5 a. Derive [A], [B] and [D] matrices for a laminate, from fundamentals. State the assumption to be made in the derivation. **(16 Marks)**

b. What are the types of laminates given below? Mention which elements of [A], [B] and [D] are zero for each one of them. i) [0 / 90 / 0 / 90] ii) [± 30]. **(04 Marks)**

6 a. Explain with neat sketches, i) Pultrusion process ii) Autoclave process. **(12 Marks)**

b. Explain briefly different methods of cutting composite materials. **(08 Marks)**

7 a. Discuss the applications of polymer matrix composites in
i) Aircrafts ii) Space iii) Sports. **(10 Marks)**

b. Discuss in brief the characteristics of base metals used in metal matrix composites. **(10 Marks)**

8 Write short notes on the following :

a. Defects in composites
b. Sandwich constructions
c. Radiography
d. Joining of composites. **(20 Marks)**

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Second Semester M.Tech. Degree Examination, June 2012

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. Explain the following failure modes with some specific application examples:
i) Corrosion fatigue ii) Galling and spalling
iii) Fretting iv) Creep. **(10 Marks)**

b. A differential element has a combined stress state given below:
$\sigma_x = 69$ MPa, $\sigma_y = 35$ MPa, $\tau_{xy} = 31$ MPa.
The material properties of that element are:
$S_{uf} = 138$ MPa, $S_{uc} = 552$ MPa and $S_y = 125$ MPa.
Choose an appropriate failure theory based on the given data. Find the factor safety against static failure. **(10 Marks)**

2 a. Explain how S-N-P curves are plotted in a laboratory using rotating bending fatigue testing machine. **(10 Marks)**

b. Explain the effect of non-zero mean stress on S-N behaviour. **(05 Marks)**

c. A smooth unaxial rod with a cross section area of 0.003 m^2 is made from a material with an endurance strength of 300 MPa under R = –1 conditions. The ultimate tensile strength of the material is 650 MPa and the true fracture strength is 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 Morrow criterion? **(05 Marks)**

3 a. A smooth unaxial bar is subjected to a minimum stress of 35 MPa in compression. The endurance strength in reversed bending is 220 MPa. Ultimate tensile strength of the material is 500 MPa and the true fracture strength is 600 MPa. Using the modified Goodman criterion, determine the maximum tensile stress that the bar will withstand without failure is 10^6 cycles. Repeat the calculation using Morrow criterion. Comment on the difference between the two calculations and its significance. **(10 Marks)**

b. Explain the effect of the following factors on S-N behaviour:
i) Microstructure ii) Size effect
iii) Surface finish iv) Temperature. **(10 Marks)**

4 a. Explain the following:
i) Stable cyclic stress-strain hysterisis loop
ii) Cyclic hardening and cyclic softening. **(06 Marks)**

b. Material data for SAE 1045 steel with a harness of 250 BHN is given below.
Monotonic properties:
σ_y: 634 MPa, n: 0.13, k: 1145 MPa, σ_f: 1227 MPa, E_f: 1.04.
Cyclic properties:
σ_y^1 : 414 MPa , n^1: 0.18, k^1: 1344 MPa,
σ_f^1 : 1227 MPa , ϵ_f^1 : 1.00 , b: –0.095, c: –0.66.
Sketch the hysteresis loop obtained at an alternating tension/compression loading stress $\sigma = \pm 700$ MPa. **(14 Marks)**

5 a. Explain the following:
i) Sigmoidal $\frac{da}{dN} - \Delta k$ curve
ii) Effect of specimen thickness on fracture toughness.
iii) Mean stress influence on fatigue crack growth rates. **(12 Marks)**

b. A very wide 25 mm thick plate of 7075-T6 aluminum contains a single edge crack of length a = 1.0 mm. The plate is subjected to an alternating stress with S_{max} = 175 MPa and S_{min} = 0. Assuming that paries equation is applicable and A = 2.7×10^{-11} and n = 3.7, determine:
i) The critical crack length at fracture ii) The number of cycles before fracture.
Take S_y = 560 MPa and k_e = 30 MPa$\sqrt{m}$, for the material given. **(08 Marks)**

6 a. Explain the need for cumulative damage theories. Explain Palgren-miner rule for cumulative damage. **(08 Marks)**

b. A round steel shaft is repeatedly subjected to the block of nominal axial stress history shown in the table.1 given below. If the shaft is smooth with a polished surface finish, how many blocks of this stress history can be applied before failure is expected? Use linear damage theory.

Load segment	Applied cycles	Minimum stress(MPa)	Maximum stress(MPa)
1	3	–500	500
2	1	–500	650
3	10	0	650

Table.1

Use σ_f^1 :1240 MPa and b = –0.07 and S_u = 931 MPa for the material. **(12 Marks)**

7 a. Explain the following:
i) Stochastic variable.
ii) Sample data
iii) Sample mean
iv) Standard deviation.
v) Coefficient of variation. **(10 Marks)**

b. The following data from 43 specimens were obtained from rotating bending fatigue tests at constant stress level and were grouped as follows:

No. of samples failed	3	8	6	10	8	5	3
Cycles to failure(N_f)	1600	1900	2200	2500	2800	3100	3400

Calculate:
i) The mean, standard deviation and coefficient of variance.
ii) Plot the frequency distribution curve assuming the data to be normally distributed. **(10 Marks)**

8 a. Enumerate the precautions that a designer can take to minimize the chances of surface failure. **(08 Marks)**

b. Derive an expression for contact pressure distribution in parallel cylindrical contact, show the distribution of pressure schematically. **(12 Marks)**

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10MMD/MDE23

Second Semester M.Tech. Degree Examination, June 2012

Dynamics & Mechanism Design

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions.***
2. ***Use of the Brodell-son: chart for the design of the Crank-rocker linkage with optimum transmission angle and unity time ratio is allowed.***

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. Find the mobility (degrees of freedoms) of the mechanisms shown in Fig. Q1(a)-(i) and Fig. Q1(a)-(ii) **(06 Marks)**

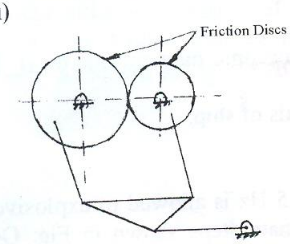

Fig. Q1(a)-(i)

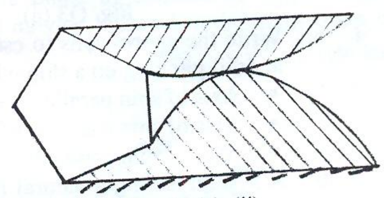

Fig. Q1(a)-(ii)

b. A 4-bar mechanism has the following proportions: L_1 = 100 mm (driver), L_2 = 200 mm (coupler), L_3 = 300 mm (O/P link). Determine the range of values for L_0 (fixed link) if linkage is to be
i) Crank rocker ii) Double crank iii) Double rocker
iv) Triple rocker v) Change point mechanism **(10 Marks)**

c. Write a short note on unique mechanism. **(04 Marks)**

2 a. Explain generalized coordinates with an example A particle is constrained to move on a fixed circular path of radius 'a' as shown in Fig. Q2 (a). Determine the Jacobean. **(10 Marks)**

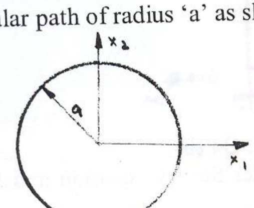

Fig. Q2 (a)

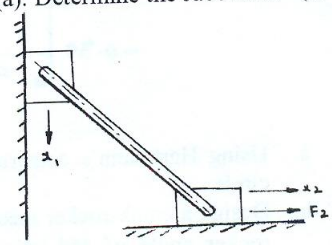

Fig. Q2 (b)

b. Explain principle of virtual work. Two frictionless blocks of equal mass 'm' are connected by a massless rigid rod, using x_1, x_2 as coordinates solve force 'F_2', if the system is in static equilibrium. Refer Fig. Q2 (b). **(10 Marks)**

3 a. A double pendulum consists of two particles suspended by massless rods, as shown in Fig. Q3 (a). Assuming that all motions take place in a vertical plane, find the differential equations of motion. Linearise these equations assuming small oscillations. **(14 Marks)**

3 b. Given a mass spring system, consisting of a mass 'm' and a linear spring of stiffness 'K' as shown in Fig. Q3 (b). Find the equations of motion using Hamiltonian procedure. **(06 Marks)**

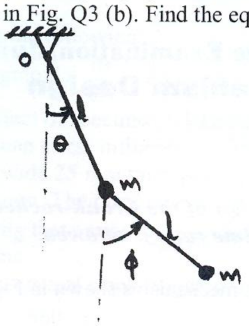

Fig. Q3 (a)

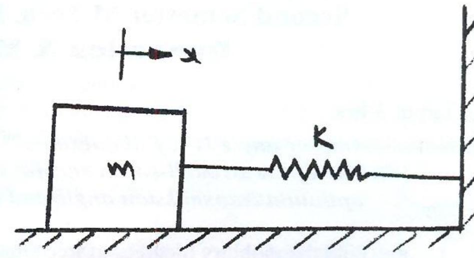

Fig. Q3 (b)

4 a. Write the expressions to estimate the gyroscopic moment due to, i) Rolling ii) Yawning and iii) pitching on a ship when

- Axis of spin parallel to longitudinal axis of ship.
- Axis of spin transverse to axis of ship.
- Axis of spin perpendicular to deck. **(08 Marks)**

b. A system having a natural frequency of 15 Hz is allowed to explosive type of input which has been changed to equivalent approximate steps shown in Fig. Q4 (b). Determine the phase plane plot and displacement-time plot. Find the maximum displacement of the system. **(12 Marks)**

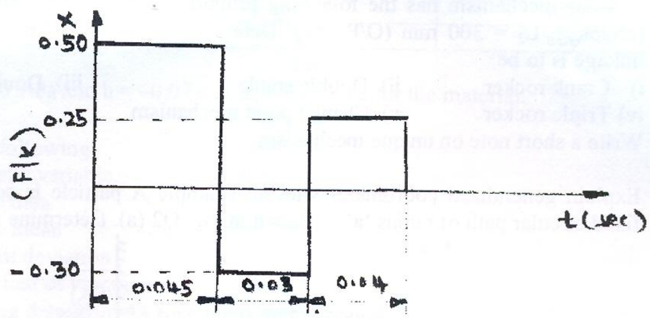

Fig. Q4 (b)

5 a. Using Hartmann's construction, derive Euler-Savary equation and hence define inflection circle. **(14 Marks)**

b. Design a crank-rocker mechanism with optimum transmission angle, a unit time ratio, and a rocker angle of 45° using a rocker 250 mm in length. Use the chart (Brodell –Soni) $\gamma_{min} = 50°$. Make a drawing of the linkage to find and verify γ_{min}, γ_{max} and φ (rocker angle). **(06 Marks)**

6 a. Design a 4-bar mechanism so that $\theta_{12} = 30^\circ$, $\theta_{23} = 30^\circ$ and $\phi_{12} = 45^\circ, \phi_{23} = 60^\circ$. Input link ($\theta$) moves in CW direction and output link (ϕ) moves in CCW direction. Use three-position (inversion) techniques. **(08 Marks)**

b. Synthesize a linkage to generate the function y = logx for $10 \le x \le 60$ using an input crank range of 120° and an output range of 90°. Length of the input lever to be 30 mm. Use 4-position (point-position reduction) synthesis. **(12 Marks)**

7 a. Synthesize a 4-bar linkage that will satisfy the following values for the angular velocities and accelerations: $\omega_2 = 20$ rad/s, $\alpha_2 = 0$ rad/s^2
$\omega_3 = 8$ rad/s, $\alpha_3 = 100$ rad/s^2
$\omega_4 = 10$ rad/s, $\alpha_4 = -150$ rad/s^2 **(08 Marks)**

b. Synthesize an offset slider crank mechanism so that the displacement of the slider is proportional to the square of the crank rotation in the interval of $45 \le \theta \le 135^\circ$. The distance of the slider from the crank shaft should be 10 cm for $\theta = 45^\circ$ and 3 cm for $\theta = 135^\circ$. Use Chebychev's accuracy points and analytical method. **(12 Marks)**

8 a. Explain Eulerian angles along with the transformation equations for the rotations. **(06 Marks)**

b. A 4 link RGGR crank-rocker mechanism is shown in Fig. Q8 (b). The knowns are the position and plane of rotation of input link, the plane of rotation of output link and dimensions of all 4 links. Find the positions of all moving links when the input crank is set to $\theta_2 = -45^\circ$ as shown in Fig. Q8 (b). **(14 Marks)**

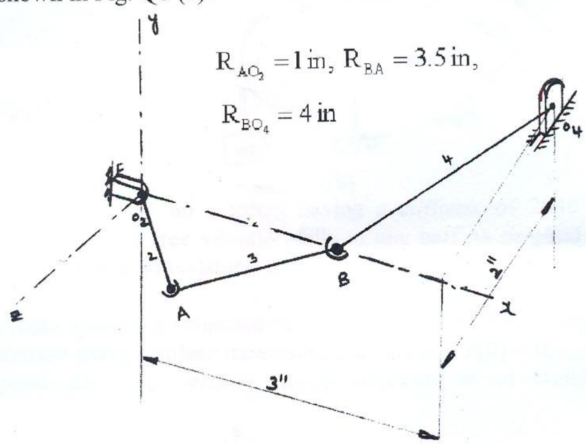

Fig. Q8 (b)

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Second Semester M.Tech. Degree Examination, June 2012
Advanced Theory of Vibrations

Time: 3 hrs. Max. Marks:100

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

1 a. Find the natural frequency of the system shown in Fig.Q.1(a). The cord can be assumed to be extensible. **(10 Marks)**

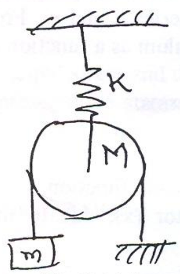

Fig.Q.1(a)

b. A mass of 2 kg is supported on a spring having a stiffness of 2940 N/m and viscous damping. If the amplitude of free vibration falls to one half its original values in 1.5 sec. Find the damping coefficient of isolator. **(10 Marks)**

2 a. A simple spring mass system is subjected to an impulse force of F_0 at time t = 0, obtain the response of the system using Laplace transformation. Assume x[0] = 0. **(10 Marks)**

b. Obtain the response for a spring-mass system subjected to an excitation as shown in Fig.Q.2(b). **(10 Marks)**

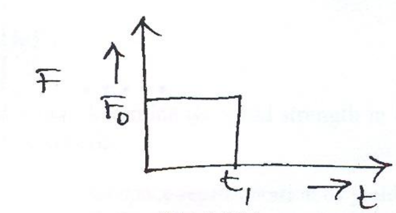

Fig.Q.2(b)

3 a. A T.V. set of 25 kg mass must be isolated from a machine vibrating with amplitude of 0.1mm at 1000 rpm. The TV set in mounted on five isolators each having a stiffness of 30,000 N/m and damping constant of 400 N-s/m. Determine: i) Amplitude of vibration of TV set; ii) Dynamic load on each isolator due to vibrations. **(10 Marks)**

b. A section of a pipe pertaining to a certain machine vibrated with large amplitudes to a compressor speed of 220rpm. For analyzing the system a spring mass system was suspended from the pipe to act as an absorber. A 1kg absorber mass tuned to 220 cpm resulted in two resonant frequencies of 188cpm and 258cpm. What must be the mass and spring stiffness of absorber if the resonant frequencies are to lie outside the range of 150rpm and 310 cpm? **(10 Marks)**

4 a. Explain the following: i) Electrodynamic exciter; ii) Signal analysis. **(10 Marks)**

b. A commercial type vibration pick up has a natural frequency of 5.75cpm and damping factor of 0.65. What is the lowest frequency beyond which the amplitude can be measured with in ±1% error? **(10 Marks)**

5 a. Explain experimental modal analysis covering the required handware. **(10 Marks)**

b. Explain the following machine vibration monitoring techniques:
i) Time domain techniques; ii) Frequency domain techniques. **(10 Marks)**

6 a. Explain at least 5 differences between linear and non-linear vibrations. **(10 Marks)**

b. Apply perturbation method to simple pendulum with sinθ replaced by $\theta - \theta^3/6$. Use only the first two terms of the series x and w. From the perturbation method find the equation for time period of the pendulum as a function of amplitude. **(10 Marks)**

7 a. Explain the following terms:
i) Autocorrelation function.
ii) Ergodic process.
iii) Power spectral density function. **(10 Marks)**

b. The eccentricity of rotor (x), due to manufacturing errors is found to have following distribution:

$$p(x) = \begin{cases} Kx^2 & 0 \le x \le 5\text{mm} \\ 0 & \text{elesewhere} \end{cases}$$

Where K in constant. Find: i) Mean; ii) Standard deviation; iii) Mean square value of eccentricity. **(10 Marks)**

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. Derive the general solution for torsional vibration of circular shaft. **(10 Marks)**

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Second Semester M.Tech. Degree Examination, June 2012
Theory of Plasticity

Time: 3 hrs. Max. Marks:100

Note: *Answer any FIVE full questions.*

1 a. Derive invariants of deviator stress tensor interms of invariants of stress tensor. **(08 Marks)**

b. Components of the stress tensor at a point with respect to x y z coordinate system is given by

$$\delta_{ij} = \begin{bmatrix} 18 & 24 & 0 \\ 24 & 32 & 0 \\ 0 & 0 & -20 \end{bmatrix} \text{MPa},$$

Determine : i) stress invariants ii) principal stress and direction of maximum principal stress iii) Octahedral shear stresses iv) Representative stress v) Hydrostatic and Deviatoric stress tensor. **(12 Marks)**

2 a. Explain the following :
i) Representative stress and Representative strain
ii) Spherical and deviator strain tensor
iii) True stress and true strain. **(08 Marks)**

b. The displacement field for a body is given by
$u = (x^2 + y)\, i + (3 + z)\, j + (x^2 + 2y)\, k$
Determine the principal strains at (3, 1, -2) and the direction of minimum principal strain. **(12 Marks)**

3 a. Explain the experimental verification of yield criteria. What is the significance of lodes stress parameter? **(12 Marks)**

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

$$[\delta_{ij}] = \begin{bmatrix} 10 & 6 & 3 \\ 6 & 20 & 5 \\ 3 & 5 & -8 \end{bmatrix} \text{MPa},$$

If the material is at yield point, determine the yield strength in tension and shear according Von-Mises and Tresca yield criteria. **(08 Marks)**

4 a. Explain Heigh –Wester gaurd stress space representation of yield criteria. **(10 Marks)**

b. Explain saint Venaut's theory of plastic flow, in detail. What are the limitations of this theory? **(10 Marks)**

5 a. Explain : i) The concept of plastic potential, ii) Convexity of yield locus. **(10 Marks)**

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

6 a. A beam of rectangular cross section 40 mm wide and 60 mm deep is 4 m in length is simply supported at the ends. It carries uniformly distributed load of intensity 'w' N/m length over the whole span. If the yield strength of the beam martial is 240 MPa, determine the value of 'w' if : i) the beam is to yield at the outmost fibre
ii) the outer 10 mm shell is to yield. **(10 Marks)**

b. For a hollow shaft made of elastic work hardening material, derive the expression for twisting moment in the shaft for elastic-plastic and full plastic yielding. Neglect the elastic shear strain. **(10 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.

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

b. An aluminum rod of 6.25 mm diameter is drawn into a wire of 5.6 mm diameter. Determine the drawing stress and tangential stress at the exit when the yield stress for aluminum 35 MPa. Neglect the friction between the rod and dies. Also determine the stresses as the aluminum rod at the entrance to the dies if the rod is extruded. (10 Marks)

8 Write short notes on :

a. Octahedral stresses
b. Yield criteria for anisotropic material.
c. Maximum work Hypothesis
d. Properties of slip lines.

(20 Marks)

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