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14MDE21

Second Semester M.Tech. Degree Examination, June/July 2015
Composite Materials Technology

Time: 3 hrs. Max. Marks:100

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

1 a. Define composite material. Explain how the mechanical advantage of the composite is measured. **(08 Marks)**

b. Briefly explain different reinforcement and matrix material used in metal matrix composite materials. State the applications of MMC. **(06 Marks)**

c. What are prepregs? Explain with neat schematic diagram the manufacturing of prepregs. **(06 Marks)**

2 a. Explain in detail how "81" independent constants are reduced to "9" independent constants for an orthotropic material. **(12 Marks)**

b. For a graphite/epoxy unidirectional lamina. Find the following:

i) Compliance matrix
ii) Minor Poissions ratio
iii) Reduced stiffness matrix
iv) Strains in the 1 – 2 coordinate system if the applied stresses are $\sigma_1 = 2MPa$, $\sigma_2 = -3MPa$, $\tau_{12} = 4MPa$.

Use the following properties: $E_1 = 181GPa$, $E_2 = 10.3GPa$, $\gamma_{12} = 0.28$, $G_{12} = 7.17GPa$. **(08 Marks)**

3 a. Derive four elastic moduli by strength of material approach. **(12 Marks)**

b. A unidirectional glass/epoxy lamina with the fibre volume fraction of 70% is replaced by graphite/epoxy lamina with same longitudinal Young's modulus, find fibre volume fraction required in graphite/epoxy lamina. Also compare the densities. Use the properties as below:

Properties	Glass	Graphite	Epoxy
Young's modulus GPa	85	230	3.4
Specific gravity	2.5	1.8	1.2

(08 Marks)

4 a. Discuss clearly the following theories of failure:
i) Tsa – Hill theory ii) Tsa – wu theory. **(08 Marks)**

b. An angle ply lamina made of S-Glass/epoxy has the following properties in the principal fibre direction:
$F_{1T} = 1280$ MPa , $F_{1C} = 622$ MPa , $F_{2T} = 49$ MPa , $F_{2C} = 245$ MPa , $F_6 = 69$ MPa , $E_6 = 3$ GPa , $E_1 = 35$ GPa , $E_2 = 7$ GPa , $\gamma_{12} = 0.3$.
A Tensile load of $\sigma_x = 2$ MPa is applied at an angle 60° to the principal fibre direction check the safety of the laminate as per failure theories as below:

i) Maximum stress theory
ii) Maximum strain theory
iii) Tsa - Hill theory. **(12 Marks)**

5 a. Discuss different laminate codes with an example. **(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.Q.5(b). Use the unidirectional properties of graphite/epoxy. Assume that each lamina has a thickness of 5mm. E_1 = 181 GPa, E_2 = 10.3 GPa, γ_{12} = 0.28, G_{12} = 7.17 GPa. **(10 Marks)**

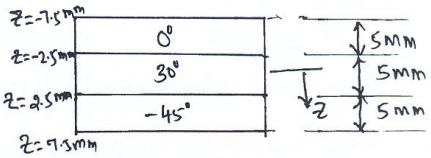

Fig.Q.5(b)

6 a. Discuss the following:
i) Laminate design for strength ; ii) Laminate design for stiffness. **(08 Marks)**

b. An E-glass-polyester composite laminate comprising of woven cloth, CSM and woven roving plies are required to support a tensile load. The particulars of the plies are given below. Assume that the plies are perfectly bonded.
Find the elastic modulus per unit width of the composite laminate.
Determine maximum load carrying capacity of the laminate in tension per unit width of the laminate. The following data may be used:

Woven cloth	CSM	WR
F_{WC} = 125 MPa	F_{CSM} = 50 MPa	F_{WR} = 165 MPa
E_{WC} = 10 GPa	E_{CSM} = 6.5 GPa	E_{WR} = 9.5 GPa
d_{WC} = 2mm	d_{CSM} = 7mm	d_{WR} = 3mm

(12 Marks)

7 a. Explain with neat sketches the following: i) Injection moulding; ii) Pultrusion process. **(10 Marks)**

b. Explain the following NDT methods: i) Radiography; ii) Ultrasonic. **(10 Marks)**

8 a. State the required properties and process for the following applications:
i) Minesweeper hull
ii) Helicopter rotor blade
iii) Racing bicycle
iv) Diesel engine piston
v) Air craft brakes
vi) Gas turbine combustor can. **(12 Marks)**

b. Write note on future potential of composites. **(08 Marks)**

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14MDE/MCS22

Second Semester M.Tech. Degree Examination, June/July 2015

Advanced Machine Design

Time: 3 hrs. Max. Marks:100

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

1 a. With the help of Mohr's circles drawn for compression and tension tests, explain clearly the differences between 'even' and 'uneven' materials. Draw the failure envelope of an uneven material according to modified Mohr's theory. **(08 Marks)**

b. What do you mean by 'synergistic failure mode'? Explain with an example. **(04 Marks)**

c. A differential element is subjected to the following stresses:
$\sigma_x = 68$ MPa, $\sigma_y = -136$ MPa and $\tau_{xy} = -136$ MPa.
The material of this element has an ultimate tensile strength of 340 MPa and ultimate compressive strength of 612 MPa. Calculate the factor of safety by using an appropriate theory of failure. Draw the failure locus. **(08 Marks)**

2 a. Explain the following: i) High cycle fatigue, ii) Low cycle fatigue. **(05 Marks)**

b. Explain the effect of the following on S-N behavior:
i) Microstructure ii) Surface finish iii) Size **(05 Marks)**

c. Sketch a family of S-N-P curves and explain the utility of such curves. **(05 Marks)**

d. Sketch and explain direct stress fatigue testing machine. **(05 Marks)**

3 a. How are constant fatigue life diagrams drawn? Using constant life diagrams superimposed with yield criterion, explain the effect of tensile and compressive mean stress. **(08 Marks)**

b. As forged 50 mm diameter 1040 steel rod has $S_u = 689$ MPa and $S_y = 516$ MPa. It is subjected to constant amplitude cyclic bending. Determine the following values using appropriate fatigue models:
i) Fully reversed bending 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 cycles if R = 0. **(12 Marks)**

4 a. Explain the effect of: i) Surface finish and (ii) Mean stress on ϵ-N behaviour of materials. Also explain SWT parameter. **(08 Marks)**

b. Material data for cyclic properties of SAE 1045 with a hardness of 225 BHN is given below in Table.Q4(a). The ultimate tensile strength is 724 MPa and young's modulus is 200 GPa. Sketch the hysteresis loop obtained at an alternating tension and compression of ±700 MPa. Also estimate the transition fatigue life.

σ'_y	n'	k'	σ'_f	ϵ'_f	b	c
414 MPa	0.18	1344 MPa	1227 MPa	1.00	-0.096	-0.66

Table.Q4(a)

(12 Marks)

5 a. What do you mean by plane strain fracture toughness? Explain the effect of the following on plane strain fracture toughness:
i) Temperature
ii) Crack length
iii) Stress applied. **(08 Marks)**

b. A very wide plate 60 mm thick made of mill annealed Ti-6Al-4V with a through thickness central crack of length 15 mm is subjected to a nominal stress of 700 MPa normal to the crack plane. Determine:
   i) The applied stress intensity level.
   ii) If the plate was cyclically loaded between Smin = 0 and Smax = 725 MPa, determine the total number of cycles needed to failure. Take A = 2.3×10^{-11} m/cycle, n = 3.2, $K_{IC} = 123$ MPa$\sqrt{m}$, $S_y = 1090$ MPa. **(12 Marks)**

6 a. Sketch and explain a Haigh diagram for a notched part. Also sketch a modified Goodman's diagram for a notched part. **(06 Marks)**

b. Explain the following:
   i) Nueber's rule
   ii) Glinka's rule **(06 Marks)**

c. A stepped shaft shown in Fig.Q6(c) is made of alloy steel with an ultimate tensile strength of 700 MPa. It is subjected to a constant amplitude rotating bending. Estimate the magnitude of the bending moment which can be applied such that failure does not occur in 10^6 cycles. Take notch sensitivity index as 0.9.

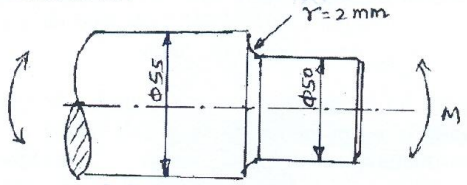

Fig.Q6(c) **(08 Marks)**

7 a. Explain the Palmgren-Miner hypothesis. **(04 Marks)**

b. State the purpose of cycle counting methods and explain level crossing method. **(06 Marks)**

c. A rod is made of a steel with Su = 450 MPa and fatigue limit of Sf = 175 MPa defined at 10^6 cycles. The rod is subjected to four fully reversed blocks of nominal stress cycling as shown in Table.Q7(c). The blocks are then repeated. Predict the expected life of the component. The component surface is smooth and has no stress concentration.

S_a (MPa)	350	300	250	200
Applied cycles	1	5	50	500

Table.Q7(c) **(10 Marks)**

8 a. Derive an expression for the pressure distribution in a spherical contact and show the pressure distribution schematically. **(10 Marks)**

b. Justify the need for contact stress analysis in mechanical engineering design. **(05 Marks)**

c. Enumerate the precautions that a designer has to take to minimize the chances of surface failure. **(05 Marks)**

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14MDE23

Second Semester M.Tech. Degree Examination, June/July 2015
Dynamics and Mechanism Design

Time: 3 hrs. Max. Marks:100

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

1 a. Explain one inversion of each of the following mechanism with neat sketches.
i) Quadratic chain ii) Single slider crank chain iii) Double slider crank chain. **(09 Marks)**

b. Draw equivalent mechanisms of the following and compute degree of freedom. **(08 Marks)**

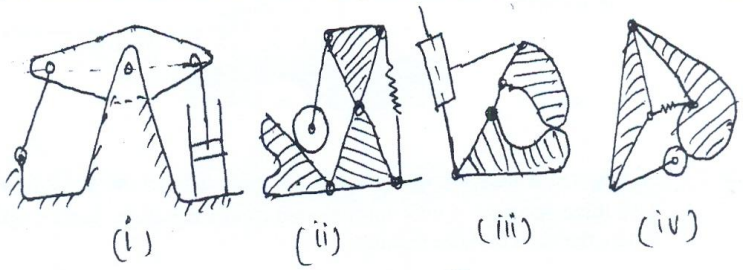


Fig.Q1(b)

c. State and explain Grashoff's law. **(03 Marks)**

2 a. Explain holonomic and Non-holonomic constraints. **(06 Marks)**

b. Explain the principle of virtual work. **(04 Marks)**

c. Find different equation of motion for a spherical pendulum of length 'ℓ' as shown in Fig.Q2(c)

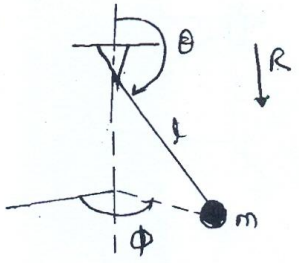


Fig.Q2(c)

(10 Marks)

3 a. Derive the expression for Lagrangian for holonomic system. **(10 Marks)**

b. Using Hamilton principles obtain equation and motions of the given system shown in Fig. Q 3(b).

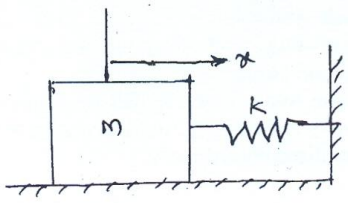


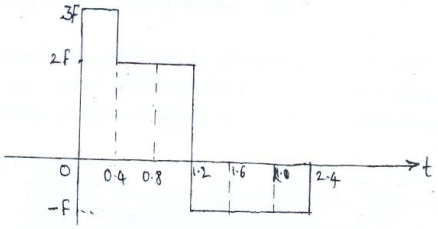
Fig.Q3 (b)

(10 Marks)

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

b. The natural period of a spring mass system is 1 second. It is subjected to pulse as shown in Fig. 4(b) plot the phase plane response.

Fig.Q4 (b)



(10 Marks)

5 Synthesize a function generator to generate a function $y = \log_{10} x$ in the range $1 \le x \le 10$. Use three accuracy points and Fruedeinstein's equation. Take length of smallest link 50mm. Make the sketch of the linkage. **(20 Marks)**

6 a. The rocker of crank rocker mechanism is to have length of 50mm and swings through a total angle of 45° with a time ratio of 1.25. Determine the suitable set of dimensions. **(08 Marks)**

b. Explain Caley's diagram for cognates. **(06 Marks)**

c. Briefly explain "Over lay method" of synthesis. **(06 Marks)**

7 a. Find degree of freedom of following mechanisms. **(08 Marks)**

Fig.Q7 (a)

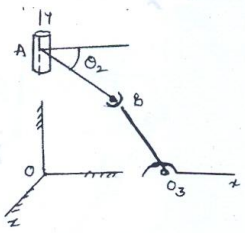


Fig (i)

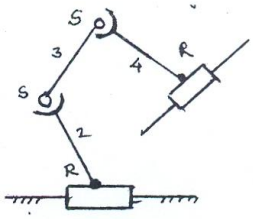


Fig (ii)

b. Define Eluerian angles and derive the equations of angular velocities. **(12 Marks)**

8 Write short notes on any five of following:

a) Path Genaration
b) Types of synthesis
c) Blooch synthesis
d) Four position synthesis (point position reduction)
e) Inflection circle
f) Position Analysis and RGGR mechanism
g) Velocity Analysis by Auxiliavy point method
h) Generalised co-ordinates. **(20 Marks)**

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14MDE24

Second Semester M.Tech. Degree Examination, June/July 2015
Advanced Theory of Vibrations

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions.***
2. Missing data, if any, may be suitably assumed.

1 a. Determine the natural frequency of the following single d.o.f. system shown in Fig. Q1(a)(i) and (ii). **(10 Marks)**

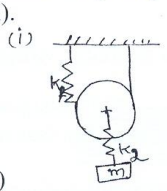

Fig.1Q(a)(i)

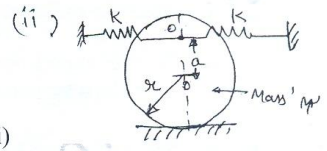

Fig.1Q(a) (ii)

b. Derive general solution for damped free vibration of a single d.o.f. system of mass 'm', spring 'k' and damper 'c', and obtain complete solution for the displacement 'x' (t) for underdamping condition. **(10 Marks)**

2 a. A single cylinder vertical petrol engine of total mass 320 kg is mounted upon a steel chassis and causes a vertical deflection of 2 mm. The reciprocating parts of the engine have a mass of 24 kg and move through a vertical stroke of 150 mm with S.H.M. A dash pot attached to the system offers a resistance of 490 N at a velocity of 0.3 m/s determine : i) the speed of the driving shaft at resonance and ii) the amplitude of steady state vibration when the driving shaft of the engine rotates at 480 rev/min. **(10 Marks)**

b. An air compressor of 450 kg operates at a constant speed of 1750 rev/min. Rotating parts are well balanced. The reciprocating part is 10 kg and crank radius is 100 mm. The mounting introduces an effective damping of damping factor 0.15. Specify the spring for the mounting such that only 20% of the unbalanced force is transmitted to the foundation. Also determine the amplitude of transmitted force. **(10 Marks)**

3 a. Using Laplace transform obtain the expression for the response x(t) of a single degree freedom system shown in Fig. Q3(a) subjected to step input force. **(10 Marks)**

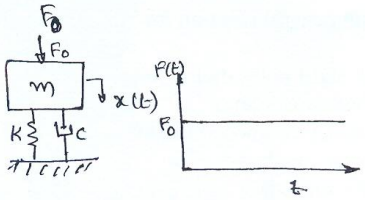

Fig.Q3(a)

b. A printed circuit board of mass 180 gms, mounted on a cantilevered bracket as shown in Fig. Q3(b) is placed in a container and dropped from a low height. The resulting shock is a half sine wave of duration $t_0 = 0.1$ sec, as shown in the figure verify whether the design of the bracket will sustain an acceleration of 100 g, under shock pulse. Assume density of material to be 2800 kg/m^3, Young's modulus 70 GPa shock amplification factor 'A' for the time ratio t_0/t_n more than 3 is 1.1 and allowable stress for the bracket is 200 MPa, bracket has cross section(15 × 12.5 mm). **(10 Marks)**

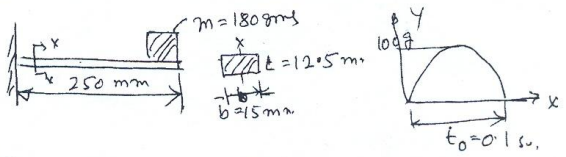

Fig.Q3(b)

4 a. List different frequency measuring instrument and explain any one. **(05 Marks)**

b. Determine the mass to be attached to the end of a Frahm tachometer in order that reed of the instrument be in resonance at a frequency of 1800 cpm. The steel rod is 50 mm long, 6 mm wide and 0.75 mm thick. Take Young's modulers 200 GPa. **(05 Marks)**

c. Explain signal analysis and experimental modal analysis with respect to basic idea and necessary equipment. **(10 Marks)**

5 a. State the differences between linear and nonlinear vibration with suitable examples. **(08 Marks)**

b. Derive expression for the time period of oscillations of a simple pendulum for large vibrations by perturbation method, (consider only first two terms of the series) **(12 Marks)**

6 a. With reference to random vibration, explain the following with suitable examples :

i) Autocorrelation and cross – correlations

ii) Stationary and ergodic random process. **(12 Marks)**

b. A random signal has a spectral density that is 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 2.00 cm. Determine its i) mean square value ii) rms value iii) standard deviation. **(08 Marks)**

7 a. A uniform string of length 'L' and large initial tension 'S' stretched between two supports is displaced laterally through a distance a_0 at the centre as shown Fig. Q7(a) and released at time t = 0. Show that the equation of motion y(t) has only odd harmonics. **(10 Marks)**

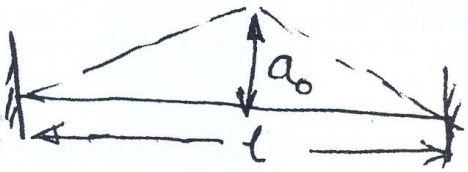

Fig.Q7(a)

b. Obtain general solution for lateral vibration of beams. **(10 Marks)**

8 Write short notes on the following :

a. Method of isoclines

b. Frequency response function

c. Spectrum analysis

d. Modal analysis. **(20 Marks)**

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14MDE252

Second Semester M.Tech. Degree Examination, June/July 2015
Theory of Plasticity

Time: 3 hrs. Max. Marks:100

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

1 a. Define octahedral strains, and derive the equation for effective shear strain. **(06 Marks)**

b. Briefly explain the factors affecting plastic deformation. **(08 Marks)**

c. 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 the plane having direction cosines

$$n_x = \frac{1}{\sqrt{6}},\ n_y = \frac{1}{\sqrt{3}},\ n_z = \frac{1}{\sqrt{2}}$$

i) Total stress
ii) Normal stress
iii) Shear stress. **(06 Marks)**

2 a. Briefly explain the following theories of strength :
i) Rankine's theory
ii) St. Venant's theory
iii) Beltrami theory
iv) Mohr's theory. **(10 Marks)**

b. Write down the idealized stress – strain diagram for the following materials indicating their equivalent mechanical models.
i) Linear – elastic
ii) Rigid strain hardening
iii) Elasto – plastic with strain hardening
iv) Rigid – perfectly plastic. **(05 Marks)**

c. The principal strains at a point in a body are given by :
$\epsilon_1 = 0.002$; $\epsilon_2 = 0.0002$; $\epsilon_3 = -0.001$
Determine the octahedral normal and shearing strains. **(05 Marks)**

3 a. Explain Lode's experiment and derive the expression for Lode's parameter. **(06 Marks)**

b. What do you understand by yield criteria? Explain the 2 yield Criteria's commonly used. **(08 Marks)**

c. The state of stress at a point is given by σ_x = 70 MPa, σ_y = 120 MPa, τ_{xy} = 35 MPa if the yield strength of the material is 125 MPa. Determine in a uniaxial tensile test, whether yielding will occur according to Tresca's and Van – Mises yield conditions or not. **(06 Marks)**

4 a. Explain the mechanism of plastic deformation by slip in pure crystal. **(06 Marks)**

b. Explain Taylor and Quinney's experiments in support of yield criterias. What are the important Conclusion's to be drawn from these experiments? **(06 Marks)**

c. What is pie–plane? How the yield criterias can be represented on the pie – plane. **(08 Marks)**

5 a. For a beam with non –linear stress – strain curve, derive the equation for bending for the case of negligible elastic strain. **(06 Marks)**

b. A rectangular beam of 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 mid span if.

i) The outer most fibres of the beam just start yielding

ii) The outer shell upto 30 mm depth yields

iii) Whole of the beam yields. Assume linear strain idealized curve for the beam material. **(08 Marks)**

c. For a bar with non – linear, stress-strain behaviour. Derive torsion equation in the form of $\frac{T}{J_n} = \frac{\tau}{\gamma^n} = F\left(\frac{\theta}{\ell}\right)^n$ with negligible elastic shear–strain. **(06 Marks)**

6 a. Show that the drawing of a rod/wire without friction can be reduced in cross–section by a maximum value of 63%. **(08 Marks)**

b. List out the assumptions made in wire drawing process by considering the effect of friction. **(04 Marks)**

c. A strip of steel 20 mm wide and 5 mm thick is drawn through friction less 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)**

7 a. Explain the following categories of forging :

i) Open–die forging with its limitations.

ii) Impression–die forging with its advantages

iii) Closed–die forging with advantages. **(09 Marks)**

b. Explain the concept of forces distributed on the rolls, during simple rolling process. **(06 Marks)**

c. List out the properties of slip lines. **(05 Marks)**

8 a. Derive Geiringer equations for incompressible 2D–flow, considering slip line equations. **(10 Marks)**

b. List out different methods of construction of slip lines and explain any two. **(10 Marks)**

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