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10ME61

Sixth Semester B.E. Degree Examination, June/July 2015
Computer Integrated Manufacturing

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Define Automation. Explain the different types of automation. **(08 Marks)**

b. Explain the following automation strategies :
i) Specialization of operator ii) Online Inspection. **(04 Marks)**

c. The parts produced in a certain batch has to be processed through an average of 6 machines. There are 20 new batches of parts launched each week. Other data as follows :
i) Average operation time = 0.1 Hr ; ii) Average setup time = 5 Hr ;
iii) Average non – operation time = 10 Hr ; iv) Average Batch size = 25 parts.
There are 18 work centers in the plant and the plant operates for an average of 70 production Hr/week. Determine i) Manufacturing lead time ii) Plant capacity iii) Production rate iv) Plant utilization. **(08 Marks)**

2 a. Explain Synchronous transfer method and Asynchronous transfer method of work transport in automation. **(08 Marks)**

b. Explain with neat sketches, the following transfer mechanisms :
i) Walking beam transfer bar system ii) Geneva mechanism. **(12 Marks)**

3 Explain the following related to analysis of an automated flow lines :
a. Partial automation.
b. Lower bound approach.
c. Upper bound approach.
d. Effect of storage. **(20 Marks)**

4 a. Explain the following terms related to line balancing : **(06 Marks)**
i) Total work context time ii) Assembly line balance iii) Line balancing.

b. The table below defines the precedence relationships and elements times for a new model :
i) Construct the precedence diagram
ii) If the Ideal time = 1 min
iii) Use Kilsridge and Westers method to assign the work station to each element and compute the balance delay and line efficiency. **(14 Marks)**

Work element	1	2	3	4	5	6	7	8	9	10	11	12
Te(min)	0.25	0.45	0.35	0.4	0.32	0.2	0.27	0.7	0.6	0.38	0.5	0.43
Preceded by	-	1	1	1	2	2,3	4	4	5	6,7	8	9,10,11

PART – B

5 a. List the principles used in product design for automated assembly. **(06 Marks)**

b. With a neat sketch, explain elements of parts delivery system. **(08 Marks)**

c. Define AGVS. List the advantages and applications of AGVS. **(06 Marks)**

6 a. With a block diagram, explain variant CADD system. **(10 Marks)**
b. What is Material requirement? Explain the structure of a MRP system. **(10 Marks)**

7 a. Discuss the advantages and disadvantages of CNC systems. **(10 Marks)**
b. Explain the fundamental steps involved in part programming for turning and milling. **(10 Marks)**

8 a. Explain the different configuration of robot, with neat sketches. **(12 Marks)**
b. Explain the following terms related to robots :
i) End effectors ii) Programming methods. **(08 Marks)**

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10ME62

Sixth Semester B.E. Degree Examination, June/July 2015
Design Machine Elements – II

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. Use of machine design data handbook is permitted.

PART – A

1 a. Determine the value of 't' in the cross section of a curved machine member shown in Fig. Q1(a), so that the normal stresses due to bending at extreme fibers are numerically equal. Also determine the normal stresses so induced at extreme fibers due to a bending moment of 10 KN – m. **(10 Marks)**

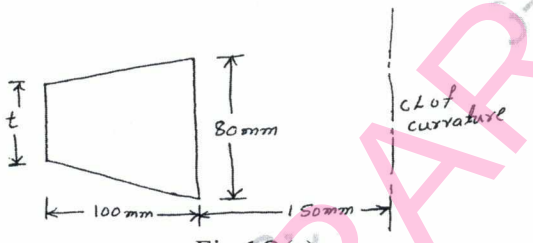

Fig.1Q(a)

b. A cast iron cylindrical pipe of outside diameter 300 mm and inside diameter 200 mm is subjected to an internal fluid pressure of 20 N/mm^2 and external fluid pressure of 5 N/mm^2. Determine the tangential and radial stresses at the inner, middle and outer surface. Sketch the tangential and radial stress distribution across its thickness. **(10 Marks)**

2 a. A nylon core flat belt 200 mm wide weighing 20 N/m, connecting a 300mm diameter pulley to a 900 mm diameter driven pulley at a shaft spacing of 6 m, transmits 55.2 kW at a belt speed of 25 m/sec i) calculate the belt length and the angles of wrap ii) compute the belt tensions based on a co-efficient of friction 0.38. **(10 Marks)**

b. Two shafts one metre apart are connected by a V – belt to transmit 90 kW at 1200 rpm of a driver pulley of 300 mm effective diameter. The driven pulley rotates at 400 rpm. The angle of groove is 40° and the co-efficient of friction between the belt and the pulley rim is 0.25. The area of the belt section is 400 mm^2 and the permissible stress is 2.1 MPa. Density of belt material is 1100 kg/m^3. Calculate the number of belts required and the length of the belt. **(10 Marks)**

3 a. A railway wagon weighting 50 kN and moving with a speed of 8 km/hr has to be stopped by four buffer springs in which the maximum compression allowed is 220 mm. Find the number of turns or coils in each spring of mean diameter 150mm. The diameter of spring wire is 25 mm. Take G = 84 GPa. Also find the shear stress. **(10 Marks)**

b. A multi leaf spring with camber is fitted to the chassis of an automobile over a span of 1.2 m to absorb shocks due to a maximum load of 20 kN. The spring material can sustain a maximum stress of 0.4 GPa. All the leaves of the spring were to receive the same stress. The spring is required at least 2 full length leaves out of 8 leaves. The leaves are assembled with bolts over a span of 150 mm width at the middle. Design the spring for a maximum deflection of 50 mm. **(10 Marks)**

4 Design a bronze spur gear 81.4 MN/m^2 and mild steel pinion 101 MN/m^2 to transmit 5 KW at 1800 rpm. The velocity ratio is 3.5 : 1. Pressure angle is 14½°. Not less than 15 teeth are to be used on either gear. Determine the module and face width. Also suggest suitable surface hardness for the weaker member based on dynamic and wear considerations. **(20 Marks)**

PART – B

5 a. A pair of mitre gears have pitch diameter 280 mm and face width of 36 mm and run at 250 rpm. The teeth are of 14½° involute and accurately cut and transmit 6 KW. Neglecting friction angle, find the following : i) outside diameter of gears ii) resultant tooth load tangent to pitch cone iii) radial load on the pinion iv) trust on the pinion. Assume low carbon cast steel 0.2 %C heat treated as the material for both the gears. **(12 Marks)**

b. The following data refer to a worm and worm gear drive that has to transmit 15 KW at 1750 rpm of the worm. Centre distance = 200 mm number of starts = 4, transmission ratio = 20 pitch circle diameter of worm = 80 mm, axial module = 8 mm tooth form = 20°FDI. The worm gear has an allowable bending stress of 55 MPa. The worm is made of hardened and ground steel. Determine : i) the number of teeth on the worm gear ii) the lead angle iii) face width of the worm gear based on the beam strength of the worm gear. **(08 Marks)**

6 a. In a multiple disc clutch the radial width of the friction material is to be 0.2 of maximum radius. The co-efficient of friction is 0.25. The clutch is to transmit 60 KW at 3000 rpm. Its maximum diameter is 250 mm and the axial force is limited to 600 N. Determine i) number of driving and driven discs ii) mean unit pressure on each contact surface. Assume uniform wear. **(10 Marks)**

b. A differential band brake shown in Fig. Q6(b) operates on a drum diameter of 500 mm. The drum rotates at 300 rpm in counter clockwise direction and absorbs 36 KW, $\mu = 0.25$ determine : i) force F required to operate the brake ii) width of band required for this brake if thickness is 5 mm and allowable tensile stress on band material is 72 N/mm^2 iii) design the lever if the maximum force is twice that of calculated force. Use C30 steel (σ_u = 540 MPa) and FOS = 4 based on ultimate stress. And also depth equal to thrice the width. **(10 Marks)**

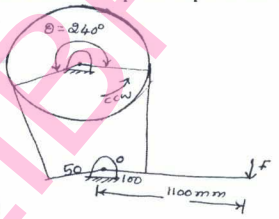

Fig.6Q(b)

7 a. Derive Pertroff's equation for a lightly loaded bearing. **(10 Marks)**

b. A full journal bearing 50 mm in diameter and 50 mm long operates at 1000 rpm and carries a load 5 kN. The radial clearance is 0.025 mm. The bearing is lubricated with SAE 30 oil and the operating temperature of oil is 80°C. Assume the attitude angle as 60°. Determine : i) bearing pressure ii) sommerfield number iii) attitude iv) minimum film thickness v) heat generated vi) heat dissipated if the ambient temperature is 20°C vii) amount of artificial cooling if necessary. **(10 Marks)**

8 Design a suitable aluminium alloy piston with two compression rings and one oil ring for a petrol engine of following particulars :

Cylinder diameter	= 0.10 m
Peak gas pressure	= 3.2 MPa
Mean effective pressure	= 0.8 MPa
Average side thrust	= 2400 N
Skirt bearing pressure	= 0.22 MPa
Bending stress in piston crown	= 36 MPa
Crown temperature difference	= 70°C.
Heat dissipated through crown	= 157 kJ/m^{2}s = 157 KW/m^2
Allowable radial pressure	= 0.04 MPa
Bending piston on rings	= 90 MPa
Heat conductivity k	= 160 W/m/°C

Assume any further data required for the design. **(20 Marks)**

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10ME63

Sixth Semester B.E. Degree Examination, June/July 2015
Heat and Mass Transfer

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. Use of heat transfer data hand book permitted.

PART – A

1 a. State the laws governing three basic modes of heat transfer. **(06 Marks)**

b. A furnace has a composite wall constructed of a refractory material for the inside layer and an insulating material on the outside. The total wall thickness is limited to 60 cms. The mean temperature of the gases within the furnace is 850°C, the external air temperature is 30°C and the temperature of the interface of the two materials of the furnace wall is 500°C. The thermal conductivities of refractory and insulating materials are 2 and 0.2 W/m–K respectively. The coefficients of heat transfer between the gases and refractory surface is 200 W/m^2-k and between outside surface and atmosphere is 40 W/m^2-k. Find :
i) The required thickness of each material
ii) The rate of heat loss. **(08 Marks)**

c. A small electric heating application uses 1.82 mm diameter wire with 0.71 mm think insulation. K (insulation) = 0.118 W/m-K, and h_0 = 34.1 W/m^2-k. Determine the critical thickness of insulation for this case and change in heat transfer rate if critical thickness was used. Assume the temperature difference between surface of wire and surrounding air remain unchanged. **(06 Marks)**

2 a. Derive an expression for the temperature distribution for a short fin of uniform cross section without insulated tip starting from fundamental energy balance equation. **(10 Marks)**

b. Determine the amount of heat transferred through an iron fin of thickness 5mm, height 50 mm and width 100 cms. Also determine the temperature of the centre of the fin end of the tip of fin. Assuming atmospheric temperature of 28°C. Take K = 50 W/m – K, h = 10 W/m^2 – K, Base fin temperature = 108°C. **(10 Marks)**

3 a. Explain physical significance of :
i) Biot number
ii) Fourier numbers. **(04 Marks)**

b. A steel ball of 5 cm diameter at 450°C is suddenly placed in a controlled environment of 100°C. Considering the following data, find the time required for the ball to attain a temperature of 150°C.
c_p = 450 J/kg-K, k = 35 W/m-K, h = 10 W/m^2 – K, ρ = 8000 kg/m^3. **(06 Marks)**

c. A long 15 cm diameter cylindrical shaft made of SS 314 (k = 14.9 W/m-k, ρ = 7900 kg/m^3) allowed to cool slowly in a chamber of 150°C with an average heat transfer coefficient of 85 W/m^2 – K. Determine :
i) Temperature of the centre of the shaft 25 minutes after the start of cooling process.
ii) Surface temperature at that time
iii) Heat transfer/unit length of shaft during this time period. **(10 Marks)**

4 a. Explain the significance of following non dimensional numbers :
   i) Prandtl number
   ii) Grashoff number
   iii) Nusselt number. **(06 Marks)**

b. A steam pipe 5 cm in diameter is lagged with insulating material of 2.5 cm thick. The surface temperature is 80°C and emissivity of the insulating material surface is 0.93. Find the total heat loss from 10 m length of pipe considering the heat loss by natural convection and radiation. The temperature of the air surrounding the pipe is 20°C. Also find the overall heat transfer co-efficient. **(08 Marks)**

c. A hot plate 1 m × 0.5 m at 130°C is kept vertically in still air at 20°C. Find :
   i) heat transfer co-efficient ii) heat lost to surroundings. **(06 Marks)**

PART – B

5 a. For flow over flat plate, discuss concepts of velocity and thermal boundary layer with sketches. **(04 Marks)**

b. Air at a free stream temperature T_∞ and velocity U_∞ flows over a flat plate maintained at a constant temperature T_w. Dimensions of the flat plate is 50 cm × 25 cm. Compare the heat transfer co-efficient when the flow direction is along 50 cm side and 25 cm side. Assume laminar flow over entire plate. **(06 Marks)**

c. Hot air at atmospheric pressure and 80°C enters an 8 m long uninsulated square duct of cross section 0.2m × 0.2 m that passes through the attic of a house at a rate at 0.15 m^3/s. The duct is observed to be nearly isothermal at 60°C. Determine the exit temperature of the air and the rate of heat loss from the duct to the attic space. **(10 Marks)**

6 a. Derive an expression for LMTD for counter flow heat exchanger. State the assumptions made. **(10 Marks)**

b. 8000 kg/hr of air at 105°C is cooled by passing it through a counter flow heat exchanger. Find the exit temperature of air if water enters at 15°C and flows at a rate of 7500 kg/hr. The heat exchanger has heat transfer area equal to 20 m^2 and the overall heat transfer co-efficient corresponding to this area is 145 W/m^2- k. Take C_p of air = 1 kJ/kg – K and that of water (C_{pw}) = 4.18 kJ/kg – K. **(10 Marks)**

7 a. With a neat diagram, explain the typical boiling curve for water at 1 atm pressure. **(08 Marks)**

b. State and explain Fick's law of diffusion. **(04 Marks)**

c. A tube of 15 mm outside diameter and 1.5 m long is used for condensing steam at 40 KPa. Calculate the average heat transfer coefficient when the tube is : i) horizontal ii) vertical and its surface temperature is mentioned at 50°C. **(08 Marks)**

8 a. Explain briefly concept of black body with an example. **(02 Marks)**

b. State and explain :
   i) Planck's law
   ii) Kirchoff's law
   iii) Wiens displacement law
   iv) Lambert's cosine law. **(08 Marks)**

c. Two parallel plates, each of 4 m^2 area, are large compared to a gap of 5 mm separating them. One plate has a temperature of 800 K and surface emissivity of 0.6, while the other has a temperature of 300 K and a surface emissivity of 0.9. Find the net energy exchange by radiation between them. If a polished metal sheet of surface emissivity 0.1 on both sides is now located centrally between the two plates, what will be its steady state temperature? How the heat transfer would be altered? Neglect the convection and edge effects if any. Comment upon the significance of this exercise. **(10 Marks)**

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10ME64

Sixth Semester B.E. Degree Examination, June/July 2015
Finite Element Methods

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting atleast TWO questions from each part.***
2. Missing data, if any, may be suitably assumed.

PART – A

1 a. Write the stress – strain relationship for both plane stress and plane strain problems. **(06 Marks)**

b. Discuss the types of elements based on geometry. **(06 Marks)**

c. Explain the various application fields of finite element method. **(08 Marks)**

2 a. Derive an expression for total potential energy of an elastic body subjected to body force, traction force and point force. **(08 Marks)**

b. Using Raleigh's Ritz method, determine the displacement at mid point and stress in linear one-dimensional rod as shown in Fig. Q2(b). Use second degree polynomial approximation for the displacement. **(12 Marks)**

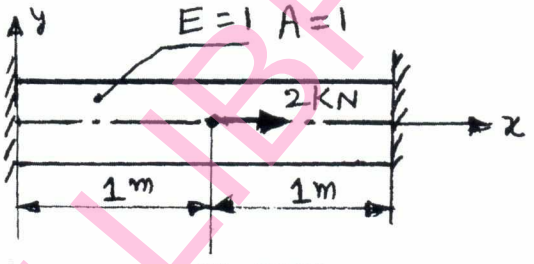

Fig.Q2(b)

3 a. Write an interpolation polynomial for linear, quadratic and cubic element. **(06 Marks)**

b. Explain simplex, complex and multiplex elements using element shapes. **(06 Marks)**

c. Derive the shape functions for a CST element. **(08 Marks)**

4 a. Solve for nodal displacement and elemental stresses for the following Fig.Q4(a), shows a thin plate of uniform thickness of 1 mm, Young's modulus = 200 GPa, weight density of the plate = 76.6×10^{-6} N/mm^3. In addition to its weight, it is subjected to a point load of 100 N at its midpoint and model the plate with 2 bar elements. **(10 Marks)**

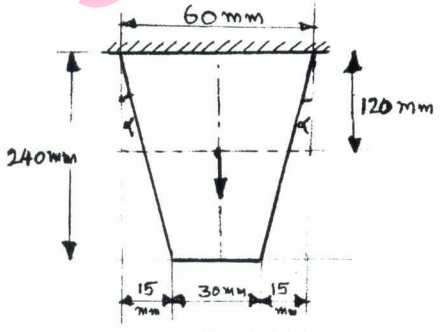

Fig.Q4(a)

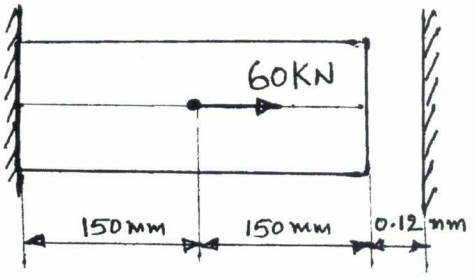

Fig.Q4(b)

b. Determine the nodal displacements, reactions and stresses for the Fig. Q4(b) using Penalty approach. Take E = 210 GPa, Area = 250 mm^2. **(10 Marks)**

PART – B

5 a. Distinguish between lower and higher order elements. **(08 Marks)**

b. Explain the concept of ISO, sub and super parametric elements and their uses. **(06 Marks)**

c. Write a note on 2 – point integration rule for 1D and 2D problems. **(06 Marks)**

6 a. Derive an expression for stiffness matrix of a truss element. **(08 Marks)**

b. For the pin-jointed configuration shown in Fig.Q6(b), formulate the stiffness matrix. Also determine nodal displacement and stress in each element. **(12 Marks)**

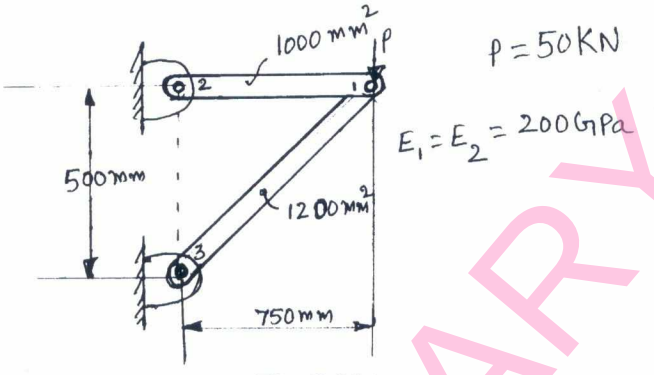

Fig.Q6(b)

7 a. Derive the Hermite shape function for a beam element. **(08 Marks)**

b. For the beam and loading shown in Fig. Q7(b), determine the slopes at 2 and 3, vertical deflection at the mid points of the distributed load. Take E = 200 GPa, I = 4×10^6 mm^4. **(12 Marks)**

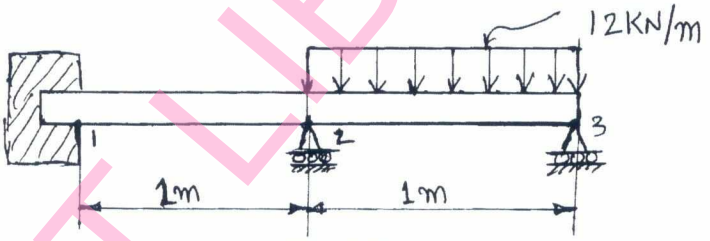

Fig.Q7(b)

8 a. Discuss the derivation of one dimensional heat transfer in thin fin. **(08 Marks)**

b. Determine the temperature distribution through the composite wall, subjected to convection heat transfer on the right side surface, with convective heat transfer co-efficient shown in Fig.Q8(b). The ambient temperature is – 5°C. Assume unit area. **(12 Marks)**

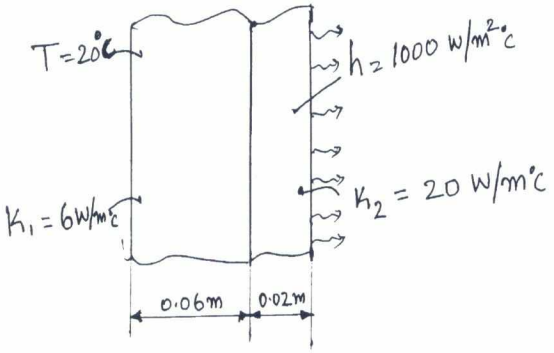

Fig.Q8(b)

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10ME65

Sixth Semester B.E. Degree Examination, June/July 2015
Mechatronics and Microprocessor

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Define Mechatronics. Briefly explain the evolution of mechatronics. **(10 Marks)**

b. What is a control system? Explain open loop and closed loop control system with suitable examples. **(10 Marks)**

2 a. How transducers are classified? **(05 Marks)**

b. Explain the following terminology : i) Accuracy ii) Repeatability iii) Sensitivity iv) Time constant v) Hysteresis. **(10 Marks)**

c. With a neat sketch, explain Hall effect sensor. **(05 Marks)**

3 a. Write a symbolic representation of Thyristor and explain its characteristics. **(10 Marks)**

b. With a neat sketch, explain the principle working of a permanent magnet stopper motor. **(10 Marks)**

4 a. What is a Multiplexer? Explain with a neat sketch, Two – channel multiplexer. **(10 Marks)**

b. What is Pulse modulation? Explain the two types of modulation. **(10 Marks)**

PART – B

5 a. With the help of symbol and truth table, explain NOT, NAND, NOR and XOR gates. **(10 Marks)**

b. Convert the following : **(10 Marks)**
i) $(654)_{10} = X_8$ ii) $(11010.01101)_2 = X_{16}$ iii) $(156.8F)_{16} = X_2$ iv) $(2747)_8 = X_{10}$.

6 a. Explain with a block diagram, the architecture of Intel 8085A processor. **(14 Marks)**

b. Enumerate the differences between microprocessor and microcontroller. **(06 Marks)**

7 a. Explain the different types of addressing modes of Intel 8085 microprocessor. **(10 Marks)**

b. Explain the following : i) Accumulator ii) Memory address iii) instruction set iv) Fetch cycle. **(10 Marks)**

8 Explain in brief the following :

a. Functions of various registers. **(10 Marks)**

b. Register organization of Intel 4004 microprocessor. **(10 Marks)**

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10ME662

Sixth Semester B.E. Degree Examination, June/July 2015
Mechanics of Composite Materials

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART - A

1 a. What is a composite material? Give detailed classification of composites. **(08 Marks)**

b. Enumerate the various applications of composites. **(08 Marks)**

c. What are prepregs? **(04 Marks)**

2 Briefly explain any two of the following process :

a. Structural Laminate bag molding.

b. Pulforming.

c. Flow molding. **(20 Marks)**

3 a. A graphite / expoxy cuboid specimen with voids has dimensions $a \times b \times c^n$ and its mass is (M_c). After it is put it into a mixture of sulfuric acid and hydrogen peroxide, the remaining graphite fibres have a mass Cm_j. From independent tests, the densities of graphite and epoxy are 'ρ' and 'ρ_m' respectively. Find the volume fraction of the voids in terms of (a, b, c, M_f, M_c, ρ_f and ρ_m). **(10 Marks)**

b. For a given glass – epoxy Lamina with a fiber volume fraction of 70%. Determine the following : i) Longitudinal elastic modulus ii) Transverse Youngs modulus iii) Major and minor Poisson ratio iv) In plane shear modulus. Take $E_f = 85Gpa$, $E_m = 3.4Gpa$ and Poisson ratio $\gamma_f = 0.2$; $\gamma_m = 0.3$. **(10 Marks)**

4 Find the following for a Lamina shown in fig. Q4 of a graphite epoxy composite.

a. Compliance matrix.

b. Minor Poissons ratio.

c. Reduced stiffness matrix.

d. Strain in the (1-2) coordinate system.

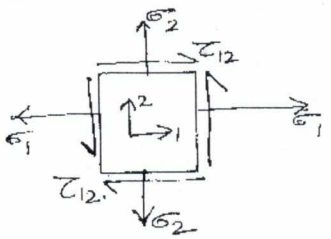

Fig.Q4

Here $\sigma_1 = 2MPa$; $\sigma_2 = -3MPa$; $\tau_{12} = 4MPa$. Take $E_1 = 181$ GPa ; $E_2 = 10.3GPa$; $\gamma_{12} = 0.28$; $G_{12} = 7.17GPa$. **(20 Marks)**

PART - B

5 a. Briefly explain the following Biaxial strength theories :

i) Maximum strain theory ii) Tsai – Hill failure theory. **(10 Marks)**

b. Find the maximum value of ($S > 0$) if a stress $\sigma_x = 2S$; $\sigma_y = -3s$; $\tau_{xy} = 4s$ are applied to a 60^0 Lamina of graphite epoxy. Use maximum stress failure theory and take ultimate strength of a unidirectional graphite / epoxy lamina as : $(\sigma_1^T)_{ult} = 1500MPa$; $(\sigma_2^T)_{ult} = 40$ MPa ; $(\sigma_1^C)_{ult} = 1500MPa$; $(\sigma_2^C)_{ult} = 246MPa$; $(\tau_{12})_{ult} = 68MPa$. **(10 Marks)**

6 a. With suitable illustrations. Explain the following laminate codes :

i) [0/-45/90/60/30] ii) $[0/-45/90_2/60/0]$ iii) $[0/-45/60]_s$ iv) $[0/-45/\overline{60}]_s$. **(10 Marks)**

b. Write a note on :

i) Stress and strain in a laminate ii) In – plane & flexural modulus of laminate. **(10 Marks)**

7 a. Briefly explain the different types of Metal Matrix Composites. **(12 Marks)**

b. With suitable diagram, explain pressure in filtration technique for fabricating MMC's. **(08 Marks)**

8 Write a note on any two :

a. Effect of size, shape and distribution of particulate on composite properties.

b. Wear studies on composite.

c. Powder metallurgy technique for fabricating composite.

d. Square casting of composites. **(20 Marks)**

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10ME665

Sixth Semester B.E. Degree Examination, June/July 2015
Non – Traditional Machining

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART - A

1 a. List and explain the various factors to be considered for selection of machining processes. **(07 Marks)**

b. Classify various non traditional machining process based in energy source used with giving suitable examples. **(06 Marks)**

c. Based on various parameters of machining, compare the conventional and non – conventions machining processes. **(07 Marks)**

2 a. Explain with graph the effect of various parameters on material removal rate (MRR) in USM process. **(10 Marks)**

b. With neat sketch, explain the main elements of ultrasonic machining process. **(10 Marks)**

3 a. Draw the schematic diagram of abrasive jet machining and explain working principle. **(08 Marks)**

b. List the applications of Abrasive jet machining. **(04 Marks)**

c. Mention the advantages and disadvantages of water jet machining. **(08 Marks)**

4 a. Explain the chemistry of ECM process with diagram. **(08 Marks)**

b. List the functions of electrolyte in ECM process. **(04 Marks)**

c. Explain with diagram, working of electro chemical grinding (ECG). **(08 Marks)**

PART - B

5 a. Explain the elements of chemical machining process. **(06 Marks)**

b. Explain with flow chart the chemical blanking process. **(10 Marks)**

c. Mention the limitations of chemical machining process. **(04 Marks)**

6 a. Explain with sketch, the mechanism of metal removal in electric discharge machining. **(07 Marks)**

b. Explain the elementary relaxation circuit for EDM. **(07 Marks)**

c. Explain the different methods of dielectric flushing in electric discharge machining. **(06 Marks)**

7 a. Explain with diagram the working of plasma arc machining. **(10 Marks)**

b. What are the factors that govern the performance of plasma arc machining? Explain anyone of them. **(06 Marks)**

c. Write the applications of plasma arc machining. **(04 Marks)**

8 a. Explain with sketch, the working of electron beam machining (EBM). **(10 Marks)**

b. What are the Applications of EBM? **(04 Marks)**

c. What are the advantages and applications of laser beam machining (LBM)? **(06 Marks)**

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