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06ME61

# Sixth Semester B.E. Degree Examination, December 2010
# Design of Machine Elements – II

Time: 3 hrs. Max. Marks:100

**Note:** ***1. Answer any FIVE full questions, selecting at least TWO questions from each part.***
***2. Use of design data handbook is permitted.***
***3. Missing data, if any, may suitably be assumed with justification.***



## PART – A

1 a. Derive an expression for normal stresses due to bending at the extreme fibres on the cross section of a curved machine member. **(08 Marks)**

b. Determine the value of 't' in the cross section of a curved machine member shown in Fig.1(b), so that the normal stresses due to bending at extreme fibres are numerically equal. Also determine the normal stresses so induced at extreme fibres due to a bending moment of 10 kN-m. **(12 Marks)**

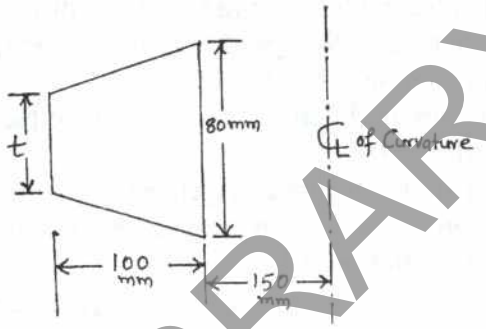


Fig.1(b).

2 a. A cast steel cylinder of 350 mm inside diameter is to contain liquid at a pressure of 13.5 N/mm$^2$. It is closed at both ends by flat cover plates which are made of alloy steel and are attached by bolts.

i) Determine the wall thickness of the cylinder, if the maximum hoop stress in the material is limited to 55 MPa.

ii) Calculate the minimum thickness necessary of the cover plates if the working stress is not to exceed 65 MPa. **(08 Marks)**

b. A shrink fit assembly, formed by shrinking one cylinder over another, is subjected to an external pressure of 60 N/mm$^2$. Before the fluid is admitted, the internal and external diameters of the assembly are 120 mm and 200 mm respectively and the diameter at the junction is 160 mm. If after shrinking on, the contact pressure at the junction is 8 N/mm$^2$, determine using Lame's equations, the stresses at inner, mating and outer surfaces of the assembly after the fluid has been admitted. **(12 Marks)**

3 a. A semi elliptical laminated spring has effective length of 1 m. The spring has to sustain a load of 75 kN. The spring has 3 full length leaves and 16 graduated leaves. If the leaves are prestressed such that the stress induced in all the leaves is same and are limited to 400 MPa, when maximum load is applied. The width of the leaves is 9 times the thickness. Assume E = 200 GPa. Determine :

i) The width and thickness of the leaves.

ii) The initial space that has to be provided between full length leaves and the graduated leaves before the band is applied.

iii) Load on the clip to close the initial gap. **(10 Marks)**

b. A load of 2 kN is dropped axially on a close coiled helical spring from a height of 250 mm. The spring has 20 effective turns and it is made of 25 mm diameter wire. The spring index is 8. Find the maximum shear stress induced in the spring and the amount of compression produced. Take G = 82.7 GPa. **(10 Marks)**

4 a. State the advantages of gear drives when compared to chain or belt drives. **(04 Marks)**

b. Design a helical gear pair to transmit a power of 15 kW from a shaft rotating at 1000 rpm to another shaft to be run at 360 rpm. Assume involute profile with a pressure angle of 20°. The material for pinion is forged steel SAE 1030 whose $\sigma_o$ = 172.375 MPa and the material for the gear is cast steel 0.20% C untreated with $\sigma_o$ = 137.34 MPa. The gears operate under a condition of medium shocks for a period of 10 hrs per day. Check for dynamic load, if load factor C = 580 N/mm and also for wear load. **(16 Marks)**

## PART – B

5 Design a pair of bevel gears to connect two shafts at 60°. The power transmitted is 25 kW at 900 rpm of pinion. The reduction ratio desired is 5:1. The teeth are 20° full depth involute and pinion has 24 teeth. Check the design for dynamic and wear considerations. **(20 Marks)**

6 a. Design a single plate clutch having both sides effective form the following data :
Power transmitted = 30 kW; speed of shaft = 1500 rpm;
Allowable lining pressure = 0.147 MPa;
Maximum diameter of clutch = 300 mm; service factor = 1.5;
Number of springs = 9;
Compression of spring during engagement = 2.5 mm. **(12 Marks)**

b. Determine the torque that may be resisted by the single block brake shown in Fig.6(b) below for a coefficient of friction 0.3. **(08 Marks)**

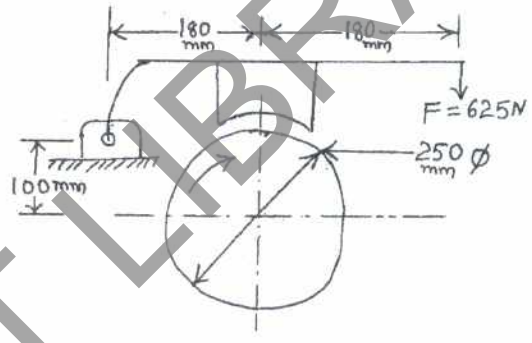


Fig.6(b).

7 a. Explain mechanism of hydrodynamic journal bearing. **(04 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) Sommerfeld number; iii) Attitude ; iv) Minimum film thickness; v) Heat generated ; vi) Heat dissipated if the ambient temperature is 20°C and vii) Amount of artificial cooling if necessary. Use McKnee's and Pederson's equations. **(16 Marks)**

8 a. A 25 mm 6 x 37 steel wire rope is used in a mine of 80 m deep. The velocity of the cage is 2 m/sec, and the time required to accelerate the cage to the desired velocity is 10 secs. The diameter of the drum is 1.25 m. Determine the safe load that the hoist can handle by assuming a factor of safety as 8. Neglect the impact load on the rope. **(12 Marks)**

b. A leather belt 125 mm wide and 6 mm thick, transmits power from a pulley 750 mm diameter which runs at 500 rpm. The angle of the lap is 150° and the coefficient of friction between the belt and the pulley is 0.3. If the belt density is 1000 kg/m$^3$ and the stress in the belt is not to exceed 2.75 N/mm$^2$, find the power that can be transmitted by the belt. Also find the initial tension in the belt. **(08 Marks)**

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06ME62

# Sixth Semester B.E. Degree Examination, December 2010
# Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

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



## PART – A

1 a. Define : i) Degrees of freedom ; ii) Simple harmonic motion. **(04 Marks)**

b. Explain : i) Types of vibrations ; ii) Beats phenomenon. **(08 Marks)**

c. A harmonic motion is given by $x(t) = 10 \text{ Sin } \left(30t - \frac{\pi}{3}\right)$ mm, where 't' is in seconds and phase angle in radians. Find : i) Frequency and period of motion ; ii) Maximum displacement, velocity and acceleration. **(08 Marks)**

2 a. The ratio K/m of a spring-mass system is given as 4.0. If the mass is deflected 20 mm down, measured from its equilibrium position, and given an upward velocity of 80 mm/s, determine its amplitude and maximum acceleration. **(10 Marks)**

b. Find the time period of small vibrations of an inverted pendulum and spring-mass system shown in Fig.Q.2(b). The pendulum is vertical in the equilibrium position. Is there any limitation on the value of 'K'? Discuss. **(10 Marks)**

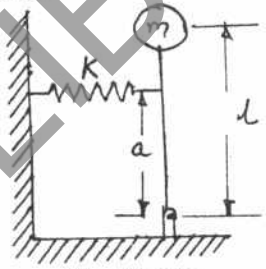


Fig.Q.2(b).

3 a. Derive an expression for oscillatory motion of a spring-mass-damper system, given the initial conditions as $x = x_0$ at $t = 0$ and $\dot{x} = 0$ at $t = 0$. **(10 Marks)**

b. A machine weighing 7.6 kg is mounted on springs and is fitted with a dashpot to damp out vibrations. There are three parallel springs each of stiffness 1 N/mm and it is found that the amplitude of vibration diminishes form 38.4 mm to 6.4 mm in two complete oscillations. Assume that the damping force varies proportionately with velocity. Determine :
i) The resistance of the dashpot at unit velocity ; ii) The ratio of frequency of damped vibration to frequency of undamped vibration ; iii) The periodic time of the damped vibration. **(10 Marks)**

4 a. A reciprocating pump, 200 kg, is driven through a belt by an electric motor at 3000 rpm. The pump is mounted on isolators with total stiffness of 5 MN/m and damping of 3.125 kN-s/m. Determine the vibrating amplitude of the pump at the running speed due to fundamental harmonic force of excitation, 1kN. Also determine the maximum vibratory amplitude when the pump is switched 'ON' and the motor speed passes through resonant condition. **(10 Marks)**

b. Define displacement and transmissibility. Deduce an expression for the same. Sketch or plot its vibration with frequency ratio for different amounts of damping. **(10 Marks)**

## PART – B

5 a. Derive an expression for the deflection of the shaft mounted with a disc at the centre, when the centre of gravity of the disc is displaced from the geometric centre by a distance 'e'. Neglect the effect of air damping and the mass of the shaft. Also, show that the critical speed of the shaft is equal to the natural frequency of lateral vibration of the shaft. **(10 Marks)**

b. A device used to measure torsional acceleration consists of a ring having a moment of inertia of 0.049 kg-m$^2$ connected to a shaft by a spiral spring having a scale of 0.98 N-m/rad, and a viscous damper having a constant of 0.11 N-m-sec/rad. When the shaft vibrates with a frequency of 15 cpm, the relative amplitude between the ring and the shaft is found to be 2°. What is the maximum acceleration of the shaft? **(10 Marks)**

6 a. Write notes on :
i) Generalized and principal co-ordinates
ii) Normal mode of vibration. **(06 Marks)**

b. Determine the natural frequency and normal modes of vibration for the system shown in Fig.Q.6(b). Also determine the response of the system when $x_1(0) = 1$, $\dot{x}_1(0) = 0$, $x_2(0) = 0$, $\dot{x}_2(0) = 0$ **(14 Marks)**

Fig.Q.6(b).

7 a. The differential equation of motion for the longitudinal vibration of uniform bar is $\frac{\partial^2 u}{\partial x^2} = \frac{1}{a^2}\frac{\partial^2 u}{\partial t^2}$, where $a^2 = \frac{E}{\rho}$, E is the Young's modulus, ρ is the density of the material. Obtain the general solution to this equation. Also derive an expression for free longitudinal vibration, when the bar is fixed at one end and free at the other. **(12 Marks)**

b. State and prove Maxwell's reciprocal theorem. **(08 Marks)**

8 Use Holzer's method to determine the first three natural frequencies for torsional vibration of four-degree-of-freedom system as shown in Fig.Q.8. **(20 Marks)**

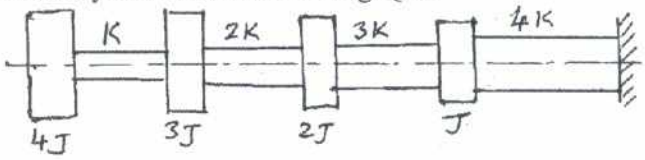

Fig.Q.8

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06ME63

# Sixth Semester B.E. Degree Examination, December 2010
# Modeling and Finite Element Analysis

Time: 3 hrs. Max. Marks:100

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



## PART – A

1 a. Explain, with a sketch, plain stress and plain strain for two dimensions. **(06 Marks)**

b. State the principles of minimum potential energy. Explain the potential energy, with usual notations. **(06 Marks)**

c. What are the steps involved in Rayleigh-Ritz method? Determine the displacement at mid point and stress in linear one-dimensional rod as shown in Fig.1(c). Use second degree polynomial approximation, for the displacement. **(08 Marks)**

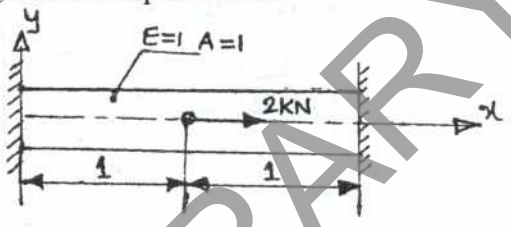



Fig.1(c).

2 a. Bring out the four differences in continuum method with finite element method. **(04 Marks)**

b. What do you understand FEM? Briefly explain the steps involved in FEM, with example. **(10 Marks)**

c. Write properties of stiffness matrix K. Show the general node numbering and its effect on the half bandwidth. **(06 Marks)**

3 a. What is an interpolation function? **(02 Marks)**

b. What are convergence requirements? Discuss three conditions of convergence requirements. **(08 Marks)**

c. Write a shot notes on :
   i) Geometrical isotropy for 2D Pascal triangle
   ii) Shape function for constant strain triangular (CST) element, with a sketch. **(10 Marks)**

4 a. Derive the shape functions for the one-dimensional bar element, in natural co-ordinates. **(08 Marks)**

b. Derive the shape functions for a four-node quadrilateral element, in natural co-ordinates. **(08 Marks)**

c. Write four properties of shape functions. **(04 Marks)**

## PART – B

5 a. Derive the following :
   i) Element stiffness matrix ($K^e$).
   ii) Element load vector ($f^e$)
   by direct method for one-dimensional bar element. **(12 Marks)**

b. Derive inverse of the Jocabian transformation matrix ($J^{-1}$) for constant strain triangle (CST). **(08 Marks)**

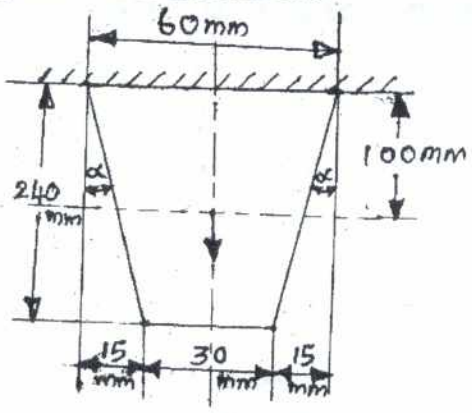
6 a. Explain with a sketch, one-dimensional heat conduction. **(06 Marks)**

b. Derive the element matrices, using Galerkin approach, for heat conduction in one dimensional element. **(10 Marks)**

c. Explain heat flux boundary condition in one dimension. **(04 Marks)**

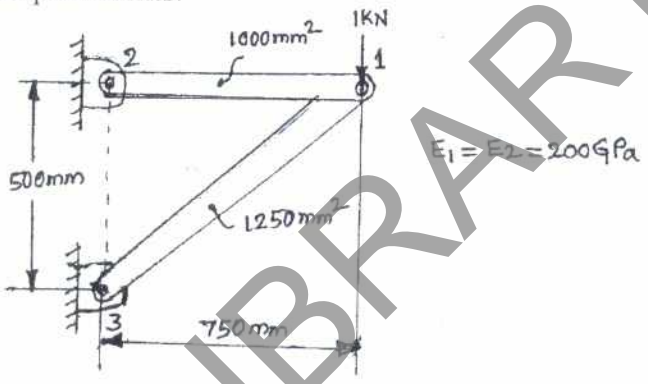
7 a. Solve for nodal displacements and elemental stresses for the following. Fig.Q.7(a), shows a thin plate of uniform 1mm thickness, Young's modulus E = 200 GPa, weight density of the plate = $76.6 \times 10^{-6}$ N/mm$^2$. In addition to its weight, it is subjected to a point load of 1 kN at its mid point and model the plate with 2 bar elements. **(10 Marks)**

Fig.Q.7(a).



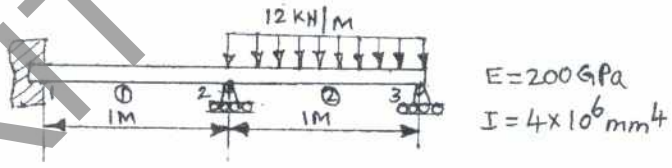

b. For the pin-jointed configuration shown in Fig.Q.7(b), formulate the stiffness matrix. Also determine the nodal displacements. **(10 Marks)**

Fig.Q.7(b).



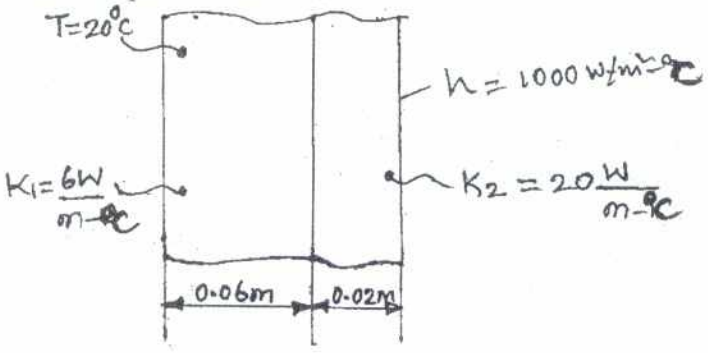

8 a. Solve for vertical deflection and slopes, at points 2 and 3, using beam elements, for the structure shown in Fig.Q.8(a). Also determine the deflection at the centre of the portion of the beam carrying UDL. **(10 Marks)**

Fig.Q.8(a).




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.Q.8(b). The ambient temperature is -5°C. **(10 Marks)**

Fig.Q.8(b).

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06ME64

# Sixth Semester B.E. Degree Examination, December 2010
# Mechatronics and Microprocessors

Time: 3 hrs. Max. Marks:100

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





## PART – A

1 a. Define mechatronics. What are its objectives? Explain with a block diagram, the key components in a typical mechatronic system. **(08 Marks)**

b. Compare the traditional design approach with that of the mechanic design approach. **(04 Marks)**

c. What is PLC? What are the basic building blocks and function of a typical PLC system? **(08 Marks)**

2 a. How are transducers classified? Explain with suitable examples. **(08 Marks)**

b. With a neat diagram, explain how angular position is determined incase of an absolute optical encoder. **(06 Marks)**

c. Explain the working principle of Hall effect sensor, with an example. **(06 Marks)**

3 a. What is bouncing in mechanical switches? Describe the hardware solution to prevent bouncing. **(06 Marks)**

b. Write a brief note on:
i) Junction field effect transistor ii) Silicon controlled rectifier. **(06 Marks)**

c. Explain with a neat sketch, the working principle of :
i) Variable reluctance stepper ii) Permanent magnet stepper **(08 Marks)**

4 a. What is an Op Amp? How is it used as a differential amplifier? **(06 Marks)**

b. What is data acquisition? Explain with a block diagram, the DAQ system. **(06 Marks)**

c. Explain the process of converting an analog signal into a digital signal. **(08 Marks)**

## PART – B

5 a. Briefly explain how the following are represented in the memory:
i) Positive and negative integer ii) Maximum integer
iii) Floating point number iv) Character representation **(08 Marks)**

b. With the help of symbol and truth table, explain NOT, NAND, NOR and XOR gates. **(08 Marks)**

c. Convert the following: i) Decimal 45816 to its hexadecimal equivalent
ii) Binary 1011.01101 to its octal equivalent. **(04 Marks)**

6 a. Explain the function and features of three forms of buses used in a microprocessor system. **(06 Marks)**

b. Discuss the following terminology, related to microprocessors: **(08 Marks)**
i) Program counter ii) Flag register iii) Instruction register iv) Instruction decoder

c. State the differences between microprocessors and microcontrollers. **(06 Marks)**

7 a. Explain with a neat layout, the internal architecture of 8085 processor. **(10 Marks)**

b. Describe the different types of addressing modes of 8085 microprocessor, with suitable examples. **(10 Marks)**

8 a. Classify 'instruction set' for Intel 8085 microprocessor and explain briefly each instruction type, with an example. **(10 Marks)**

b. With the aid of the timing diagram, explain the following machine cycles:
i) OP code fetch cycle ii) Memory read cycle **(06 Marks)**

c. Write an assembly program to add the contents of register B to the contents of register C and transfer the result to register D. **(04 Marks)**

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06ME65

# Sixth Semester B.E. Degree Examination, December 2010
# Heat and Mass Transfer

Time: 3 hrs. Max. Marks:100

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

## PART – A

1 a. Explain briefly: i) Thermal conductivity ii) Thermal diffusivity iii) Thermal contact resistance. **(06 Marks)**

b. The walls of a house in cold region consist of three layers, an outer brick work 15 cm thick, an inner wooden panel 1.2 cm thick, the intermediate layer is made of an insulating material 7 cm thick. The thermal conductivity of brick and wood are 0.7 W/mk and 0.18 W/mk respectively. The inside and outside temperatures of the composite wall are 21°C and -15°C respectively. If the layer of insulation offers twice the thermal resistance of the brick wall, calculate,
i) Heat loss per unit area of the wall.
ii) Thermal conductivity of insulating material. **(06 Marks)**

c. An insulated steam pipe having outside diameter of 30 mm is to be covered with two layers of insulation, each having a thickness of 20 mm. The thermal conductivity of one material is 3 times that of the other. Assuming that the inner and outer surface temperatures of composite insulation are fixed, how much heat transfer will be increased when the better insulation material is next to the pipe than when it is at the outer layer? **(08 Marks)**

2 a. Define fin efficiency and fin effectiveness with respect to a fin with insulated tip. **(04 Marks)**

b. What is the physical significance of critical thickness of insulation? Derive an expression for critical thickness of insulation for a sphere. **(06 Marks)**

c. The handle of a ladle used for pouring molten metal at 327°C is 30 cm long and is made of 2.5 cm × 1.5 cm mild steel bar stock (K = 43 W/mK). In order to reduce the grip temperature it is proposed to make a hollow handle of mild steel plate of 0.15 cm thick to the same rectangular shape. If the surface heat transfer coefficient is 14.5 $W/m^2K$ and the ambient temperature is at 27°C, estimate the reduction in the temperature of grip. Neglect the heat transfer from the inner surface of the hollow shape. **(10 Marks)**

3 a. Obtain an expression for instantaneous heat transfer and total heat transfer for lumped heat analysis treatment of heat conduction problems. **(08 Marks)**

b. Explain the physical significance of Biot number and Fourier number. **(04 Marks)**

c. An aluminium sphere weighing 5.5 kg and initially at a temperature of 290°C is suddenly immersed in a fluid at 15°C. The convective heat transfer coefficient is 58 $W/m^2K$. Estimate the time required to cool the aluminium to 95°C using the lumped capacity method of analysis (For aluminium, $\rho = 2700$ kg/m$^3$, C = 900 J/kgK, K = 205 W/mK) **(08 Marks)**

4 a. What do you mean by hydrodynamic and thermal boundary layer? How does the ratio $\frac{\delta_h}{\delta_t}$ vary with prandtl number? **(06 Marks)**

b. Using Buckingham's π-theorem, obtain the relationship between various non-dimensional numbers for free convection heat transfer. **(08 Marks)**

c. Air at 20°C flows over a thin plate with a velocity of 3 m/sec. The plate is 2 m long and 1 m wide. Estimate the boundary layer thickness at the trailing edge of the plate and the total drag force experienced by the plate. **(06 Marks)**

## PART – B

5 a. Water at 25°C flows through a tube of 50 mm diameter. Determine the flow rate that will result in a Reynolds number of 1600. The tube is provided with a nichrome heating element on its surface and receives a constant heat flux of 800 W/m length of the tube. Determine the average heat transfer coefficient between the water and the tube wall, assuming fully developed conditions. Also determine the length of the tube for the bulk temperature of water to rise from 25°C to 50°C. **(12 Marks)**

b. Air stream at 27°C moving at 0.3 m/sec across 100 W incandescent bulb glowing at 127°C. If the bulb is approximated by a 60 mm diameter sphere, estimate the heat transfer rate and the percentage of power lost due to convection. Use correlation $Nu = 0.37 R_{eD}^{0.6}$. **(08 Marks)**

6 a. Define effectiveness and NTU of a heat exchanger. Explain why minimum heat capacity value is used in the definition of effectiveness for the maximum possible rate of heat transfer. **(04 Marks)**

b. Derive an expression for LMTD in case of parallel flow heat exchanger stating the assumptions made. **(08 Marks)**

c. A counter flow heat exchanger is employed to cool 0.55 kg/sec (Cp = 2.45kJ/kgK) of oil from 115°C to 40°C by the use of water. The inlet and outlet temperature of cooling water are 15°C and 75°C respectively. The overall heat transfer coefficient is expected to be 1450 W/m$^2$°C. Using NTU method, calculate the following:

i) The mass flow rate of water.
ii) The effectiveness of heat exchanger.
iii) The surface area required. **(08 Marks)**

7 a. Explain :

i) Filmwise condensation and dropwise condensation.
ii) Subcooled boiling and saturated boiling. **(06 Marks)**

b. A square array of 400 tubes 15 mm outer diameter is used to condense steam at atmospheric pressure. The tube walls are maintained at 88°C by a coolent flowing through the tubes. Calculate the amount of steam condensed per hour per unit length of the tubes. **(08 Marks)**

c. State and explain Fick's law of diffusion. **(06 Marks)**

8 a. For a black body enclosed in a hemispherical space show that emissive power of the black body is $\pi$ time the intensity of radiation. **(08 Marks)**

b. State and explain:

i) Kirchoff's law.
ii) Planck's law.
iii) Wein's displacement law.
iv) Lambert's cosine law. **(08 Marks)**

c. Explain briefly the concept of a black body. **(04 Marks)**

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06ME665

# Sixth Semester B.E. Degree Examination, December 2010
# Non Traditional Machining

Time: 3 hrs. Max. Marks:100

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





## PART – A

1 a. Explain the need and characteristics features of non traditional machining. **(10 Marks)**

b. Sketch and explain any two types of tool feed systems in ultrasonic machining process. **(10 Marks)**

2 a. Explain the effect of amplitude and frequency of vibration, abrasive grain diameter, and static load on the rate of material removal and surface finish in USM. **(10 Marks)**

b. List and explain any five parameters that influence abrasive jet machining. **(10 Marks)**

3 a. With the help of a neat sketch, explain the principle of abrasive jet machining process.(AJM) **(08 Marks)**

b. Write a note on electrolytes used in ECM. **(04 Marks)**

c. Explain the various reactions taking place at the anode and cathode of ECM process. **(08 Marks)**

4 a. List the industrial applications of ECM. **(05 Marks)**

b. Differentiate ECG with the conventional grinding. **(05 Marks)**

c. Explain the following processes
   i) Electro chemical turning
   ii) Electro chemical honing. **(10 Marks)**

## PART – B

5 a. Explain the sequence of operation in chemical machining. **(08 Marks)**

b. List the factors to be considered in the selection of etchants in chemical machining. **(06 Marks)**

c. Explain with a graph, the role of current and voltage in EDM. **(06 Marks)**

6 a. Explain the working principle of EDM with a neat sketch using electro mechanical control unit. **(10 Marks)**

b. What are the functions of dielectric fluid? **(04 Marks)**

c. Explain in detail, the following process characteristics, with reference to EDM.
   i) Heat affected zone
   ii) Metal removal rate. **(06 Marks)**

7 a. Explain the mechanism of metal removal in PAM. **(06 Marks)**

b. Briefly explain the parameters that influence PAM performance. **(06 Marks)**

c. Explain the thermal features and analysis of the LBM. **(08 Marks)**

8 Write short notes on :

a. Process variables in EBM

b. Traveling wire EDM

c. Electrochemical trepanning

d. Relaxation circuit in EDM. **(20 Marks)**

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