6th ME old/New Scheme



USN | | | | | | | | | | |

06ME61

# Sixth Semester B.E. Degree Examination, June-July 2009
## 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 hand book is permitted.*
*3. Missing data, if any, may suitably be assumed.*

## PART – A

1 a. What are the assumptions made in finding stress distribution for a curved flexural member? Also state two major differences between a straight beam and a curved beam. **(05 Marks)**

b. Determine the value of steam thickness 't' in the T – cross section of a curved beam shown in Fig.Q.1(b) such that the normal stresses due to bending at the extreme inner and outer fibres are numerically equal. **(15 Marks)**

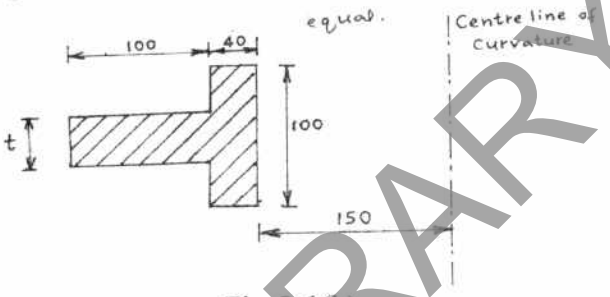



Fig.Q.1(b).

2 a. A cast steel cylinder of 300mm internal diameter is to contain liquid at a pressure of 12.5N/mm$^2$. It is closed at both ends by unstayed flat cover plates rigidly bolted to the shell flange. Determine the thickness of the cover plates if the allowable working stress for the cover material is 75N/mm$^2$. **(05 Marks)**

b. Design a shrink fit joint to join two cylinders of diameter 150mm x 200mm and 200mm x 250mm. Maximum tangential stress in the components due to shrink fitting is to be limited to 40MPa. Also determine the axial force necessary to dis-engage the joint if the length of the joint is 200mm and the maximum power that can be transmitted at a rated speed of 1000rpm. The cylinder material has a modulus of elasticity 210 GPa and Poisson's ratio 0.3. **(15 Marks)**

3 a. Derive the expression for the stress induced in helical coil spring. **(05 Marks)**

b. Design a valve spring for an automobile engine, when the valve is closed, the spring produces a force of 45N and when it opens, produces a force of 55N. The spring must fit over the valve bush which has an outside diameter of 20mm and must go inside a space of 35mm. The lift of the valve is 6mm. The spring index is 12. The allowable stress may be taken as 330 MPa and modulus of rigidity, G 80GPa. **(15 Marks)**

4 a. Define "Formative number of teeth" as applied to Helical gears and explain its importance in the design of Helical gears. **(05 Marks)**

b. Design a pair of spur gears to transmit 20 kW of power while operating for 8 to 10 hours per day sustaining medium shock, from a shaft rotating at 1000rpm to a parallel shaft which is to rotate at 310rpm. Assume the number of teeth on pinion to be 31 and 20° full depth involute tooth profile. The material for pinion is C40 steel, untreated whose $\sigma_o$ = 206.81 N/mm$^2$ and for gear is cast steel, 0.2% c, untreated whose $\sigma_o$ = 137.34 N/mm$^2$. Check the design for Dynamic load if Load factor, C = 522.464 N/mm and also for wear load taking Load stress factor, K = 0.279 N/mm$^2$. Suggest suitable hardness. **(15 Marks)**

## PART - B

5 a. Under what circumstances the Bevel gears are used? Give a detailed classification of Bevel gears. **(05 Marks)**

b. Design a worm gear drive to transmit a power of 2kW at 1000 rpm. The speed ratio is 20 and centre distance is 200mm. Assume the number of teeth on worm wheel to be 40 and number of starts on worm to be 2. Assume hardened steel worm and phosphor bronze wheel for which $\sigma_o = 55$ N/mm$^2$.
Check the gear from stand point of strength and wear if load stress factor, K = 0.69 MPa. If the amount of Heat generated is 1.7 kW, check whether artificial cooling arrangement is necessary or not for a temperature rise of 40°K. **(15 Marks)**

6 a. A multiple disc clutch has five plates having four pairs of active friction surfaces. If the intensity of pressure is not to exceed 0.127N/mm$^2$, find the power transmitted at 500 rpm. The outer and inner radii of friction surfaces are 125mm and 75mm respectively. Assume uniform wear and take co-efficient of friction as 0.3. **(05 Marks)**

b. A differential band brake as shown in Fig.Q.6(b), has an angle of contact of 225°. The band has a compressed woven lining and bears against a cast iron drum of 350mm diameter. The brake is to sustain a torque of 350 N.m. and the co-efficient of friction between the band and the drum is 0.3. Find:
i) The necessary force, P for the clockwise and anticlockwise rotation of the drum and
ii) The value of 'OA' for the brake to be self locking, when the drum rotates clockwise. **(15 Marks)**

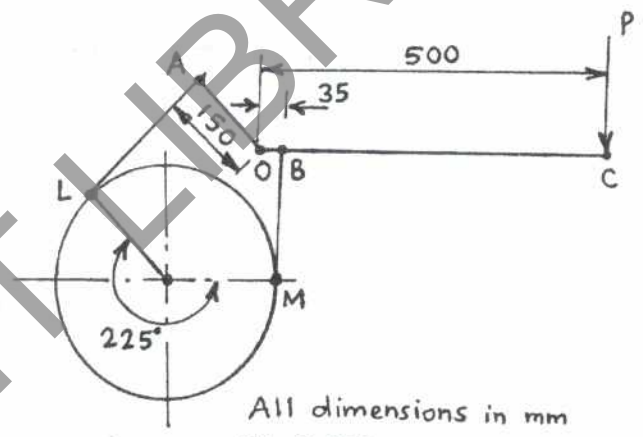


Fig.Q.6(b).

7 a. Derive Petroff's equation for a lightly loaded bearing. **(05 Marks)**

b. Design a full journal bearing subjected to 6kN at 1000rpm of the journal. The journal is of hardened steel and the bearing is of babbit material. The bearing is operated with SAE40 oil at 70°C and the ambient temperature is 30°C. Also determine the amount of artificial cooling required. **(15 Marks)**

8 a. Derive the expression for the ratio of Tensions in belt drive without considering the effect of centrifugal Tension. **(05 Marks)**

b. Two shafts 1 metre apart are connected by a V-belt to transmit 90kW at 1200 rpm of a driver pulley of 300mm effective diameter. The driver 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 400mm$^2$ and the permissible stress is 2.1 MPa. Density of belt material is 1100kg/m$^3$. Calculate the number of belts required and the length of the belt. **(15 Marks)**

* * * * *

USN | | | | | | | | | | |

06ME62

# Sixth Semester B.E. Degree Examination, June-July 2009
## Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

**Note:** ***1. Answer any FIVE full questions, selecting at least TWO questions from each part.***
***2. Assumptions if made should be stated explicitly.***

### PART – A

1 a. Add the following motions analytically and check the solution graphically.
$x_1 = 4\text{Cos}\ (wt + 10^o)$
$x_2 = 6\ \text{Sin}\ (wt + 60^o)$ **(10 Marks)**

b. Represent the periodic motions given by following Fig.Q.1(b) by harmonic series. **(10 Marks)**

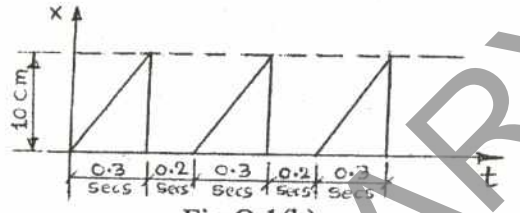



Fig.Q.1(b).

2 a. A cylinder of mass m and mass moment of inertia Jo rolling without slipping but restrained by two linear springs of stiffness $k_1$ and $k_2$ as shown in Fig.Q.2(a). Determine:
i) The natural frequency of vibration of the system
ii) The value of "a" for which the natural frequency is maximum. **(10 Marks)**

b. Determine the natural frequency of oscillation of the system shown in Fig.Q.2(b) where the mass less rigid bar is hinged at O.

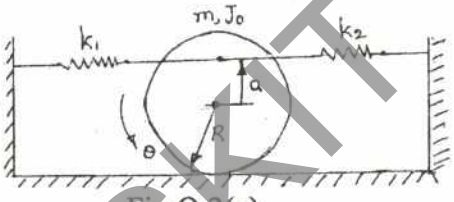



Fig.Q.2(a).

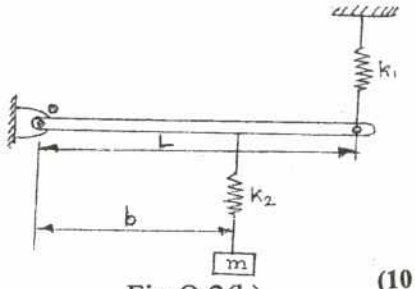



Fig.Q.2(b). **(10 Marks)**

3 a. Set up the differential equation for a spring mass damper system and obtain the complete solution for the under damped condition. **(10 Marks)**

b. A simple pendulum is pivoted at point O as shown in Fig.Q.3(b). Assuming small oscillations and neglecting the mass of the rod, find the damped natural frequency of the pendulum. **(10 Marks)**

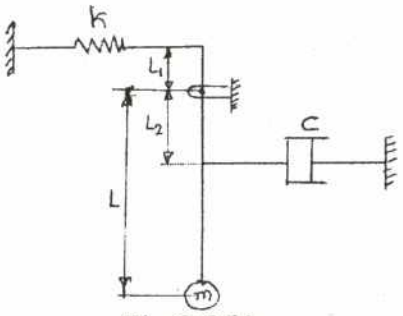



Fig.Q.3(b).

4 a. A 54 N weight is suspended by a spring with a stiffness of 1100 N/m. It is forced to vibrate by a harmonic force of 5 N. Assuming a viscous damping of C = 77 N-s/m, find

i) The resonant frequency.
ii) The amplitude at resonance
ii) The phase angle at resonance
iv) The damped natural frequencies
v) The frequency at which maximum amplitude of vibration occurs. **(10 Marks)**

b. Derive an expression for the transmissibility and transmitted force for a spring mass damper system subjected to external excitation. **(10 Marks)**

## PART - B

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

b. A rotor has a mass of 12 kg and is mounted midway on a 24 mm diameter horizontal shaft supported at the ends by two bearings. The bearings are 1m apart. The shaft rotates at 2400 rpm. If the centre of mass of the rotor is 0.11mm away from the geometric centre of the rotor due to a certain manufacturing inaccuracies, find the amplitude of the steady state vibration and the dynamic force transmitted to each bearing. Take E = 200 GPa. **(10 Marks)**

6 a. Derive the frequency equation for the Pulley – mass system shown in Fig.Q.6(a). The pulley has a mass of M and effective radius of R. Assume that the cord, which passes over the pulley, does not slip. If $k_1$ = 60 N/m, $k_2$ = 40 N/m, m = 2kg and M = 10 kg. Determine the natural frequencies and mode shapes. **(14 Marks)**

b. Explain the principle of dynamic vibration absorber? What is the main disadvantage of such an absorber? **(06 Marks)**

7 a. The governing equation of lateral vibration of beam is $\frac{\partial^2 y}{\partial t^2} + a^2 \frac{\partial^4 y}{\partial x^4} = 0$ where, $a = \sqrt{\frac{EI}{PA}}$ obtain a general solution for the governing differential equation. **(10 Marks)**

b. Find the natural frequency of vibration for the system shown in Fig.Q.7(b) by the Dunkerley's method. Take E = 1.96 x $10^{11}$ N/m$^2$ and I = 4 x $10^{-7}$ m$^4$. **(10 Marks)**

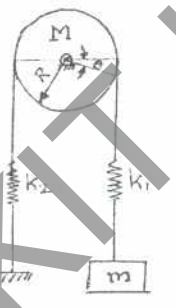



Fig.Q.6(a).

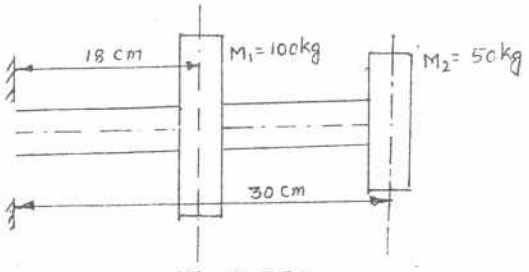



Fig.Q.7(b).

8 a. Write a note on influence coefficients. **(05 Marks)**

b. Find the natural frequency of the system shown in Fig.Q.8. Use Holzers method. **(15 Marks)**

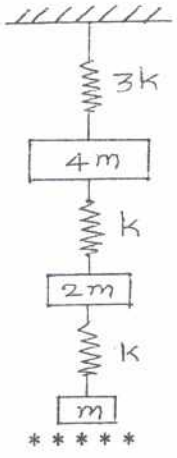



Fig.Q.8(b)

* * * * *

USN | | | | | | | | | | |

06ME65

# Sixth Semester B.E. Degree Examination, June-July 2009
# 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. Derive an expression for the temperature distribution and the rate of heat transfer for a hollow cylinder. **(10 Marks)**

b. An electrical resistance of mattress type is inserted in between two slabs of different materials on a panel heater. On one side, the material has a thermal conductivity of 0.174W/m °K and 10mm thick. On the other side of the heater the material has a thermal conductivity of 0.05W/m °K and 25mm thick. The convection heat transfer co-efficient from the thinner and thicker slabs are 23.26 and 11.63 $W/m^2$ °K. The temperature of the surrounding air on both the sides is 15°C. If the energy dissipation for each square meter of the mattress is 5kW, neglecting edge effects, find (i) The surface temperature of the slab. (ii) The temperature of the mattress assuming it to be the same as the inner surface of the slabs. **(10 Marks)**

2 a. Derive an expression for the temperature distribution for a pin fin, when the tip of the fin is insulated. **(08 Marks)**

b. A steel pipe of 220mm OD is carrying steam at 280°C. It is insulated with a material with K=0.06[1 + 0.0018T] where 'K' is in W/m °K. Thickness of insulation is 50mm and the outer surface temperature is 50°C. Determine the heat flow per 'm' length of the pipe and the temperature at the mid thickness of the pipe. **(12 Marks)**

3 a. Derive an expression for the instantaneous and total heat flow in terms of the product of Biot Number and Fourier Number in one dimensional transient heat conduction. **(08 Marks)**

b. A 5cm thick iron plate with K = 60 W/m °K, $C_p$ = 460 J/kg °C, ρ = 7850 $kg/m^3$, $\alpha=1.6\times10^{-5}$ $m^2/s$ is initially at 225°C. Suddenly both the surfaces are exposed to an environmental temperature of 25°C with a convective heat transfer co-efficient of 500$W/m^2$ °K. Calculate
i) the centre temperature at t = 2 min after start of cooling
ii) the temperature at a depth of 1 cm from the surface at t = 2 min after the start of cooling
iii)the energy removed from the plate per $m^2$ during this time. **(12 Marks)**

4 a. The exact expression for local Nusselt Number for the laminar flow along a surface is given by $N_{ux}=\frac{h_x.x}{K}=0.332\,Pr^{1/3}\,Re_x^{1/2}$. Show that the average heat transfer coefficient from x = 0 to x = L over the length 'L' of the surface is given by $2h_L$ where $h_L$ is the local value at x=L. **(08 Marks)**

b. A tube of 0.036m OD and 40cm length is maintained at a uniform temperature of 100°C. It is exposed to air at a uniform temperature of 20°C. Determine the rate of heat transfer from the surface of the tube when (i) the tube is vertical (ii) the tube is horizontal. **(12 Marks)**

## PART – B

5 a. Explain the physical significance of i) Prandtl Number ii) Reynold's Number iii) Nusselt Number iv) Grashoff Number. **(08 Marks)**

b. The surface temperature of a thin plate located parallel to air stream is 90°C. The free stream velocity is 60m/s and the air temperature is 10°C. The plate is 60cmwide and 45cm long in the direction of air stream. Assuming that the transitional Reynold's number is $4\times10^5$, determine i) The average heat transfer co-efficient in laminar and turbulent regions ii) Rate of heat transfer for the entire plate considering both the sides of the plate. Given that the correlations for the local Nusselt Number are $0.332\ (Re_x)^{1/2}\ Pr^{1/3}$ for laminar flow and $0.028(Re_x)^{0.8}\ Pr^{1/3}$ for turbulent flow. **(12 Marks)**

6 a. Derive an expression for LMTD for a parallel flow heat exchanger. **(10 Marks)**

b. A cross flow heat exchanger in which both fluids are unmixed is used to heat water with an engine oil. Water enters at 30°C and leaves at 85°C at a rate of 1.5 kg/s, while the engine oil with $C_p$ = 2.3 kJ/kg °K enter at 120°C with a mass flow rate of 3.5 kg/s. The heat transfer surface area is 30 $m^2$. Calculate the overall heat transfer co-efficient by using LMTD method. **(10 Marks)**

7 a. Clearly explain the regions of pool boiling with a neat sketch. **(06 Marks)**

b. Define i) Mass concentration
ii) Molar concentration **(04 Marks)**

c. Air free saturated steam at a temperature of 65°C ($p$ = 25.03kPa) condenses on a vertical outer surface of a 3m long vertical tube maintained at a uniform temperature of 35°C. Assuming film condensation, calculate the average heat transfer co-efficient over the entire length of the surface. Calculate the average heat transfer co-efficient and rate of condensate flow (taking the data same as for a vertical tube) for a horizontal tube of 2.5cm outer diameter. **(10 Marks)**

8 a. Explain i) Steam Boltzman law
ii) Kirchoff's law
iii) Plank's law
iv) Wein's displacement law
v) Radiation shield. **(10 Marks)**

b. Two large parallel plates with $\epsilon = 0.5$ each, are maintained at different temperatures and are exchanging heat only by radiation. Two equally large radiations shields with surface emissivity 0.05 are introduced in parallel to the plates. Find the percentage reduction in net radiative heat transfer. **(10 Marks)**

* * * * *

USN | | | | | | | | | | |

06ME63

# Sixth Semester B.E. Degree Examination, June-July 2009
# 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 the principle of minimum potential energy and principle of virtual work. **(06 Marks)**

b. Evaluate the integral $I = \int_{-1}^{+1} (3\xi^3 + 2\xi^2 + \xi + 2) d\xi$ by using 2 point and 3 point Gauss quadrature. **(06 Marks)**

c. Solve the following system of simultaneous equations by Gauss Elimination method:

$$x_1 - 2x_2 + 6x_3 = 0$$
$$2x_1 + 2x_2 + 3x_3 = 3$$
$$-x_1 + 3x_2 = 0$$

**(08 Marks)**

2 a. Explain briefly about node location system. **(06 Marks)**

b. Explain preprocessing and preprocessing in FEM. **(06 Marks)**

c. Explain the basic steps involved in FEM. **(08 Marks)**

3 a. What are the considerations for choosing the order of polynomial functions? **(06 Marks)**

b. Explain convergence requirements of a polynomial displacement model. **(06 Marks)**

c. Derive the linear interpolation polynomial in terms of natural co-ordinate for 2-D triangular elements. **(08 Marks)**

4 a. What are Hermite shape functions of beam element? **(06 Marks)**

b. Derive the shape function for a quadratic bar element using Lagrangian method. **(06 Marks)**

c. Derive the shape function for a nine noded quadrilateral element. **(08 Marks)**

## PART – B

5 a. Derive the element stiffness matrix for truss element. **(10 Marks)**

b. Derive the Jacobian matrix for 2D triangular element. **(10 Marks)**

6 a. Explain the types of boundary conditions in heat transfer problems. **(10 Marks)**

b. Discuss the Galerkin approach for 1-D heat conduction problem. **(10 Marks)**

7 a. Using the direct stiffness method, determine the nodal displacements of stepped bar shown in figure Q7 (a). **(10 Marks)**

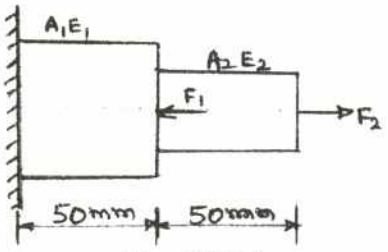
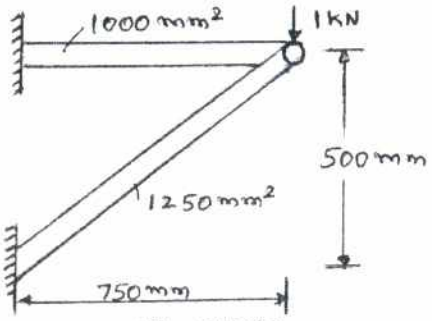



Fig. Q7 (a)

$E_1 = 200$ GPa
$E_2 = 70$ GPa
$A_1 = 150$ mm$^2$
$A_2 = 100$ mm$^2$
$F_1 = 10$ kW
$F_2 = 5$ kW

7 b. For the truss shown in figure Q7 (b), find the assembled stiffness matrix. **(10 Marks)**




$E_1 = E_2 = 200$ GPa

Fig. Q7 (b)

8 a. Determine the temperature distribution through the composite wall subjected to convection heat loss on the right side surface with convective heat transfer coefficient shown if figure Q8 (a). The ambient temperature is -5°C. **(10 Marks)**

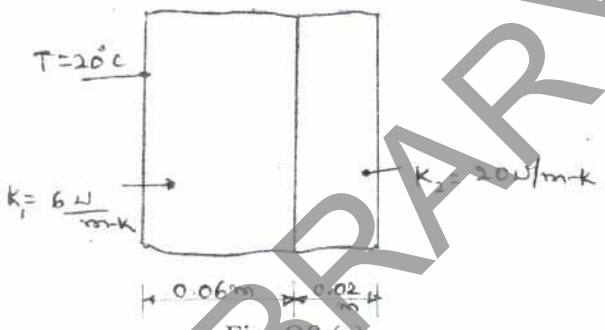
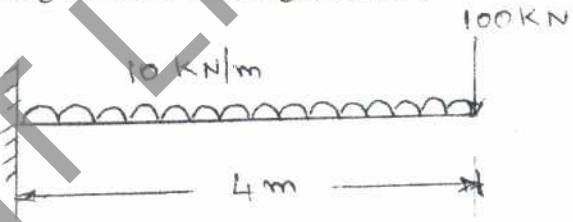



Fig. Q8 (a)

b. Determine the maximum deflection in the uniform cross section of Cantilever beam shown in figure Q8 (b) by assuming the beam as a single element. **(10 Marks)**




$E = 7 \times 10^9$ N/m$^2$
$I = 4 \times 10^{-4}$ m$^4$

Fig. Q8 (b)

* * * * *

USN | | | | | | | | | | |

06ME64

# Sixth Semester B.E. Degree Examination, June-July 2009
## Mechatronics and Microprocessor

Time: 3 hrs. Max. Marks:100

**Note: 1.** ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
**2.** ***Draw neat sketches wherever necessary.***

### PART – A

1 a. Define mechatronics. State the major differences between conventional and mechatronic product design approach. **(08 Marks)**

b. What is sequential controller and explain with a block diagram the working of an domestic washing machine. **(12 Marks)**

2 a. Explain how sensing is achieved by an incremental optical encoder. **(08 Marks)**

b. Explain the following performance terminologies of transducers :
i) Accuracy ii) Repeatability iii) Drift iv) Speed of response **(06 Marks)**

c. Explain the principle of operation of Hall effect sensor. **(06 Marks)**

3 a. Differentiate between a diode, thyristor and transistor. **(06 Marks)**

b. Explain the working principle of a permanent magnet D.C. motor. How it is used for positive control drives. **(08 Marks)**

c. Sketch and explain the working of an stepper motor. **(06 Marks)**

4 a. What is the significance of operational amplifier? How it is used in an inverting amplifier circuit? **(10 Marks)**

b. What is multiplexer and de multiplexer? Where they are used? **(06 Marks)**

c. Write a note on digital signal processing. **(04 Marks)**

### PART – B

5 a. With the help of a block diagram, explain briefly the general form of a microprocessor system. **(08 Marks)**

b. What are logic gates? Discuss AND and OR gates with their truth tables for two inputs. **(08 Marks)**

c. Write a note on representation of real numbers. **(04 Marks)**

6 a. Explain in detail with a block diagram, the architecture of Intel 8085A microprocessor. **(10 Marks)**

b. What are micro controllers? Explain the general form of a micro controller. **(10 Marks)**

7 a. Explain the classification of instructions for the Intel's 8085 microprocessor. **(10 Marks)**

b. With a neat flow chart, discuss the programming process. **(10 Marks)**

8 a. Distinguish between instruction cycle, machine cycle and T-state. **(10 Marks)**

b. Draw and explain the timing diagram for Opcode fetch operation. **(10 Marks)**

* * * * *

USN | | | | | | | | | | |

06ME667

# Sixth Semester B.E. Degree Examination, June–July 2009
# Project Management

Time: 3 hrs. Max. Marks:100

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

## PART - A

1 a. Explain with neat sketch project life cycle curve. **(10 Marks)**

b. Define a project, categorise projects with examples. **(10 Marks)**

2 a. Explain the various factors of feasibility report of a project. **(10 Marks)**

b. Explain the objectives and goals of a project. **(10 Marks)**

3 a. What are the skills and abilities required for a project manager? **(10 Marks)**

b. Define tender and contract. Explain the various steps for the selection of contractors. **(10 Marks)**

4 A project has the following time schedule.

| Activity | Time in weeks | Activity | Time in weeks |
|---|---|---|---|
| 1 - 2 | 5 | 5 – 7 | 9 |
| 1 – 3 | 2 | 6 – 8 | 2 |
| 2 – 4 | 2 | 7 – 8 | 3 |
| 3 – 4 | 2 | 8 - 9 | 2 |
| 3 – 5 | 6 | 8 – 10 | 9 |
| 4 – 9 | 5 | 9 - 10 | 7 |
| 5 - 6 | 4 | | |

Construct PERT network and compute

a. $T_E$ and $T_L$ for each event.

b. Float for each activity.

c. Critical path and its duration. **(20 Marks)**

## PART - B

5 a. With a neat sketch, explain the various stages of project direction. **(10 Marks)**

b. Define control and explain the various types of project control. **(10 Marks)**

6 a. Explain the various performance indicators used in project management. **(10 Marks)**

b. Explain CM and DM companies with a block diagram. **(10 Marks)**

7 a. Explain the project termination strategies. **(10 Marks)**

b. Explain the methods of supply and transportation of materials to projects. **(10 Marks)**

8 Write short notes on the following :

a. Communication in a project. **(05 Marks)**

b. Tools and Techniques of project management. **(05 Marks)**

c. Gantt chart. **(05 Marks)**

d. Project Manager. **(05 Marks)**

*****

USN | | | | | | | | | | |

06ME665

# Sixth Semester B.E. Degree Examination, June-July 2009
# 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. Compare the conventional machining with non traditional machining processes. **(06 Marks)**

b. Explain how the non-traditional machining processes are classified? **(06 Marks)**

c. Explain with sketch the principle of operation of ultrasonic machining. **(08 Marks)**

2 a. Explain the different parameters that affect the ultrasonic machining. **(08 Marks)**

b. Calculate the depth of indentation produced on a ceramic surface in ultrasonic machining by the throwing action of abrasive grains of 150 μm diameter using following data :

Amplitude of vibration – 0.15 mm
Frequency of vibration – 21 Kc/s
Abrasive density – 3.5 Kgf/$m^2$
Yield strength of ceramic – 4.5 x $10^{11}$ N/$m^2$ **(06 Marks)**

c. Mention the advantages, disadvantages and applications of ultrasonic machining. **(06 Marks)**

3 a. Explain with schematic diagram the Abrasive jet machining process. **(07 Marks)**

b. Explain the following variables that influence the rate of metal removal and accuracy of machining in Abrasive jet machining :

i) Carrier gas ii) Types of abrasives iii) Stand off distance
v) mean number of abrasive grains per unit volume of the carrier gas. **(08 Marks)**

c. What are the advantages and applications of water jet machining? **(05 Marks)**

4 a. What are the elements of electrochemical machining process? Explain any two elements. **(06 Marks)**

b. Calculate the metal removal rate and electrode feed rate when Iron is electro chemically machined, using copper electrode and sodium chloride solution (specific resistance = 5.0 ohm.cm). The power supply data of the electro chemical machine used are :
Supply voltage – 18 VDC
Current – 5000 amps
A tool gap of 0.5 mm (constant) may be assumed.
Atomic weight of Iron = 56 ; Valency = 2
Density – 7.87 x $10^6$ g/$m^3$ **(07 Marks)**

c. Explain with schematic diagram the electro chemical grinding process. **(07 Marks)**

## PART – B

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

b. Explain with the flow chart the chemical blanking process. **(09 Marks)**

c. What are the advantages and applications of chemical machining? **(05 Marks)**

6 a. Explain with sketch the mechanism of metal removed by electric discharge machining. **(06 Marks)**

b. Explain with sketch the process of electrode feed control in Electric discharge machining. **(08 Marks)**

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

7 a. Explain with sketch the principle of plasma generation and mechanism of metal removal in plasma arc machining. **(08 Marks)**

b. What are the factors that govern the performance of plasma arc machining? Explain any one of them. **(08 Marks)**

c. Mention the safety precautions to be considered during plasma arc machining. **(04 Marks)**

8 Explain with sketch the principle of operation, mechanism of metal removal, advantages, disadvantages and applications of the following process :

a. Laser beam machining. **(10 Marks)**

b. Electron beam machining. **(10 Marks)**

* * * * *