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06ME61

Sixth Semester B.E. Degree Examination, May/June 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 hand book is permitted.

PART – A

1 a. Derive expressions for extreme fibre stresses in a curved beam subjected to pure bending moment. **(08 Marks)**

b. Determine the combined stresses at the inner and outer fibers at the critical section of a crane hook which is required to lift loads upto 50 kN. The hook has trapezoidal C.S. with inner and outer sides of 90mm and 40mm respectively. Depth is 120mm. The center of curvature of the section is at a distance of 100mm from the inner side of the section and the load line passes through the centre of curvature. Also, determine the factor of safety according to max shear stress theory, if $\tau_{all} = 80$ MPa. **(12 Marks)**

2 a. With reference to pressure vessels, what is autofrettage? Explain. **(04 Marks)**

b. A high pressure cylinder consists of an inner cylinder of ID and OD of 200mm and 300mm respectively. It is jacketed by an outer cylinder of OD 400mm. The difference between the OD of the inner cylinder and inner dia of the jacket before assembly is 0.25mm. $E = 2.07\times10^5$ MPa. Calculate the shrinkage pressure and stresses induced in cylinders due to shrinkage pressure. In service, the cylinder is further subjected to an internal pressure of 200 MPa. Plot the resultant stress distribution. **(16 Marks)**

3 a. Derive an expression for shearing stress induced in a helical spring subjected to a compressive load, P. **(07 Marks)**

b. Write a note on Wahl stress correction factor. **(03 Marks)**

c. A semi-elliptic multi-leaf spring is used for the suspension of the rear axle of a truck. It consists of two extra full length leaves and 10 graduated length leaves including the master leaf. The center to center distance between the spring eyes is 1.2m. The leaves are made of steel with $\sigma_{yt} = 1500$ MPa. $E = 2.07\times10^5$ MPa and FOS is 2.5. The spring is to be designed for a maximum force of 30 kN. The leaves are prestressed so as to equalize stresses in all leaves. Determine
i) C.S. of leaves ii) Initial nip iii) Initial pre-load required to close the gap
iv) Deflection of the spring. **(10 Marks)**

4 a. List the advantages and disadvantages of helical gears. **(03 Marks)**

b. It is required to transmit 15 kW power from a shaft running at 1200 rpm to a parallel shaft with speed reduction of 3. The centre distance of shafts is to be 300mm. The material used for pinion in steel ($\sigma_d = 200$ MPa) and for gear is CI ($\sigma_d = 140$ MPa). Service factor is 1.25 and tooth profile is 20° full depth involute. Design the spur gear and check the design for dynamic load and wear. **(17 Marks)**

PART – B

5 a. List the advantages and disadvantages of worm gear drive. **(03 Marks)**

b. A pair of straight tooth bevel gears at right angles is to transmit 5 kW at 1500 rpm of the pinion at a speed ratio of 3. Diameter of the pinion is 75mm. The tooth form is 14½° involute. Pinion is made of steel (σ_d = 160 MPa) and gear of CI (σ_d = 80 MPa). Design the gear pair and check the design for dynamic load and wear. **(17 Marks)**

6 a. Derive power transmitting capacity of a single plate clutch for
i) Uniform pressure condition and ii) Uniform wear condition. **(10 Marks)**

b. A single block brake with a torque capacity of 250 N.m is shown Fig.Q6(b). The brake drum rotates at 100 rpm and the coefficient of friction is 0.35. Calculate:
i) The actuating force and the hinge-pin reaction. ii) the rate of heat generated during the braking action and iii) The dimensions of the block, if the intensity of pressure between the block and brake drum is 1 MPa. The length of the block is twice its width. **(10 Marks)**

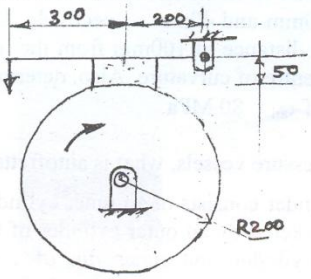

Fig.Q6(b)

7 a. Derive the Petnoff's equation coefficient of friction, in a sliding contact bearing. **(06 Marks)**

b. Following data refers to a 360° hydrodynamic bearing:
Radial load = 3.2 kN Journal speed = 1500 rpm
Journal diameter = bearing length = 50 mm Radial clearance = 0.05 mm
Viscosity of lubricant = 25 cP.
Assume that the total heat generated in the bearing is carried away by total oil flow in the bearing. Calculate:
i) Coefficient of friction ii) Power loss in friction iii) Minimum film thickness
iv) Flow requirement v) Temperature rise. **(14 Marks)**

8 a. Derive the expression for power rating of a V-belt drive. **(08 Marks)**

b. The following data is given for a V-belt drive connecting a 20 kW motor to a compressor:

	Motor pulley	Compressor pulley
Pitch dia (mm)	300	900
Speed (rpm)	1440	480
Coefficient of friction	0.2	0.2

The center distance between pulleys is 1 m. C.S. of belt is trapezoidal with parallel sides being 12mm and 22mm respectively and depth is 14mm. The density of the composite belt is 0.97 gm/cc and the allowable tension per belt is 850 N. Determine he number of belts required for this application. **(12 Marks)**

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06ME62

Sixth Semester B.E. Degree Examination, May/June 2010
Mechanical Vibrations

Time: 3 hrs. Max. Marks:100

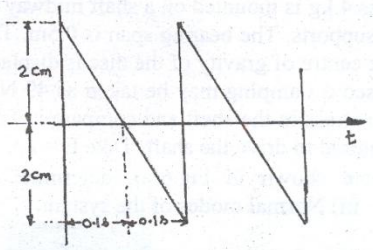
Note: ***Answer any FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. Differentiate between : i) Linear and non linear vibrations ; ii) Deterministic and random vibrations. **(04 Marks)**

b. A periodic motion observed on the oscilloscope is shown in Fig.1(b). Represent this motion by harmonic series. **(10 Marks)**

Fig.1(b)



c. Determine the resultant of the following harmonic motions analytically $x_1 = 3 \text{ Sin } (wt + \pi/3)$ and $x_2 = 5 \text{ Sin } (wt + 2\pi/3)$. **(06 Marks)**

2 a. Determine the natural frequency of spring – mass sytem taking the mass of the spring in to account. **(10 Marks)**

b. A cylinder of radius r rolls without slipping on a cylindrical surface of radius R as shown in Fig.2(b). Derive the equation for natural frequency of small oscillaitons about the lowest point. Use energy method. **(10 Marks)**

Fig.2(b).

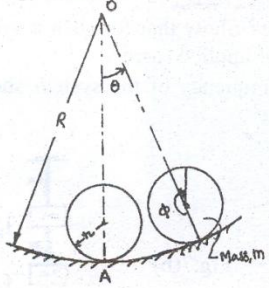
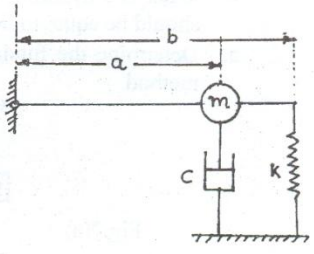


Fig.3(b).



3 a. Write the differential equation of motion for the system shown in Fig.3(a). Determine : i) Undamped natural frequency ; ii) Critical damping coefficient ; iii) Damping ratio ; iv) Damped natural frequency. **(10 Marks)**

b. In a single degree damped vibrating system, a suspended mass of 18 kg makes 10 oscillations in 8 seconds. The amplitude decreases to 25% of the initial value after 5 cycles. Determine : i) Damped natural frequency ; ii) Logarithmic decrement ; iii) Undamped natural frequency ; iv) Spring constant ; v) Damping coefficient. **(10 Marks)**

4 a. A mass of 6.12 kg, suspended by a spring of stiffness 1.2 kN/m, is forced to vibrate by a harmonic force of 10N. Assume viscous damping of 86 Ns/m. Find :
i) Frequency at resonance ; ii) Amplitude at resonance ; iii) Phase angle at resonance ; iv) Frequency corresponding to peak amplitude ; v) Peak amplitude. **(10 Marks)**

b. A machine of mass 75 kg is mounted on springs of stiffness 12 kN/cm with an assumed damping factor 0.2. A piston within the machine of mass 2 kg has a reciprocating motion with a stroke of 7.5 cm and a speed 50 Hz. Assuming the motion of the piston to be harmonic, determine : i) Amplitude of the machine ; ii) Transmissibility ; iii) Force transmitted to the foundation ; iv) The phase angle of the transmitted force with respect to the exciting force. **(10 Marks)**

PART – B

5 a. Explain the working principle of vibrometer, with their range of frequency of operation. **(08 Marks)**

b. A disc of mass 4 kg is mounted on a shaft midway between bearings which may be assumed to be simple supports. The bearing span is 0.5m. The steel shaft is horizontal and is 1 cm in diameter. The centre of gravity of the disc is displaced 3 mm from the geometric centre. The equivalent viscous damping may be taken as 49 N.s/m. If the shaft rotates at 800 rpm, find the maximum stress in the shaft and compare it with dead load stress in the shaft. Also find the power required to drive the shaft. Take $E = 2 \times 10^{11} N/m^2$. **(12 Marks)**

6 a. For the system shown in Fig.6(a), determine : i) Equation of motion ; ii) Natural frequencies ; iii) Normal modes of the system. **(08 Marks)**

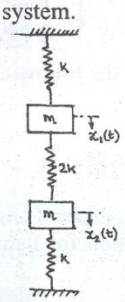


Fig.6(a)

b. What is a dynamic vibration absorber? Show that for such a system, it's natural frequency should be equal to the frequency of the applied force. **(12 Marks)**

7 a. Determine the fundamental natural frequency of the system shown in Fig.7(a) by Stodola method. **(10 Marks)**

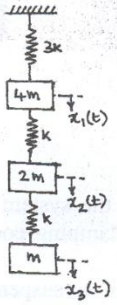


Fig.7(a)

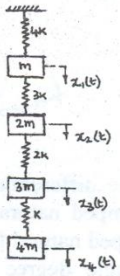


Fig.7(b)

b. Determine the fundamental natural frequency of the system shown in Fig.7(b) by Dunkerleys equation. **(10 Marks)**

8 a. Derive the equation governing the longitudinal vibrations of the bar and obtain the general solution of the differential equation derived above. **(10 Marks)**

b. Derive suitable expression for longitudinal vibrations for a rectangular uniform cross sectional bar of length *l* fixed at one end and free at the other end. **(10 Marks)**

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06ME63

Sixth Semester B.E. Degree Examination, May/June 2010
Modeling and Finite Element Analysis

Time: 3 hrs. Max. Marks:100

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

PART - A

1 a. Using Rayleigh Ritz method, find the maximum deflection of a simply supported beam with point load at center. **(10 Marks)**

b. Solve the following system of simultaneous equations by Gaussian elimination method.

$4x_1 + 2x_2 + 3x_3 = 4$

$2x_1 + 3x_2 - 5x_3 = 2$

$2x_1 + 7x_2 = 4$ **(10 Marks)**

2 a. Explain the descretization process. Sketch the different types of elements 1D, 2D, 3D elements used in the finite element analysis. **(06 Marks)**

b. Considering for element, obtain the element stiffness matrix by direct stiffness approach. Comment on its characteristics. **(09 Marks)**

c. Define a shape function. What are the properties that the shape function should satisfy? **(05 Marks)**

3 a. Explain the convergence criteria with suitable examples and compatibility requirements in FEM. **(08 Marks)**

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

c. Explain linear interpolation, polynomials in terms of global coordinates for one dimensional simplex element. **(06 Marks)**

4 a. Explain the concept of isoparametric, sub parametric and super parametric elements and their uses. **(06 Marks)**

b. Derive the shape functions for a CST element and also the displacement matrix. **(08 Marks)**

c. Derive the Hermite shape functions for a beam element. **(06 Marks)**

PART - B

5 a. Find the shape functions at point P for the CST element shown in fig. Q5(a). Also find the area and Jacobian matrix for the element. **(10 Marks)**

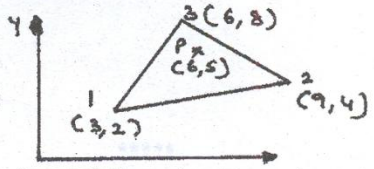


Fig.Q5(a)

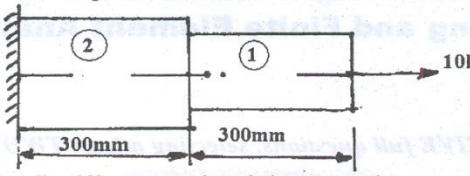
b. Derive the stiffness matrix for a 2 – dimensional truss element. **(10 Marks)**

6 a. Discuss the various steps involved in the finite element analysis of a one dimensional heat transfer problem with reference to a straight uniform fin. **(10 Marks)**

b. Explain the finite element modeling and shape functions for linear interpolation of temperature field (one – dimensional heat transfer element). **(10 Marks)**

7 a. Determine the nodal displacement and stresses in the element shown in fig. Q7(a). **(10 Marks)**

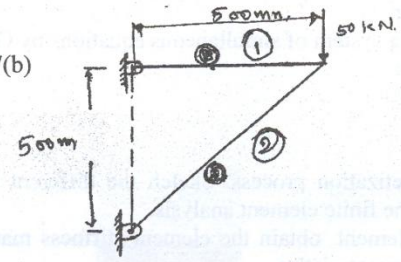
Fig.Q7(a)



$A_1 = 500\ mm^2$
$A_2 = 2000 mm^2$
$E_1 = 100\ GPa$
$E_2 = 200\ GPa$

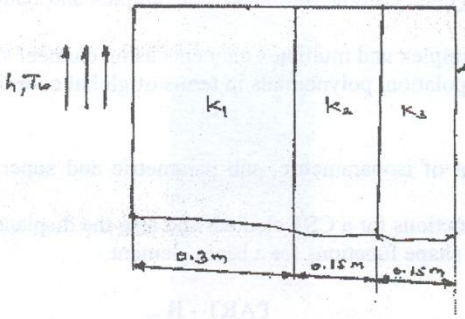
b. Obtain the overall stiffness matrix of the truss elements shown in fig. Q7(b). All the elements have an area of $200mm^2$ and elements (1) and (2) are 500mm long. E = 200 GPa. **(10 Marks)**

Fig.Q7(b)



8 A composite wall consists of three materials as shown in fig. Q8. The outer temperature $T_0 = 20^0C$. Convective heat transfer takes place on the inner surface of the wall with $T_{00} = 800^0C$ and $h = 25\ W/m^2\ ^0C$. Determine the temperature distribution on the wall. **(20 Marks)**

Fig.Q8



$k_1 = 20\ W/m^0C$
$k_2 = 30\ W/m^0C$
$k_3 = 50\ W/m^0C$
$h = 25\ W/m^2\ ^0C$
$T_\infty = 800^0C$

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06ME64

Sixth Semester B.E. Degree Examination, May/June 2010
Mechatronics and Microprocessors

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Explain with the block diagram, the basic elements of a measurement system. **(08 Marks)**

b. Explain with the block diagram, how a microprocessor control system is used to control the focusing and exposure in an automatic camera. **(12 Marks)**

2 a. Define the following terms : i) Hysteresis error ii) Repeatability. **(04 Marks)**

b. Explain with a sketch, an eddy current proximity sensor. **(06 Marks)**

c. Explain the working principle of Hall effect sensor. How can this sensor be used to determine the level of fuel in an automobile fuel tank? **(10 Marks)**

3 a. Write short notes on relays. **(05 Marks)**

b. Explain the principle of brushless D.C. permanent magnet motor. **(08 Marks)**

c. Explain the principles of operation of the variable reluctance stepper motor. **(07 Marks)**

4 a. With suitable examples, explain some of the processes that can occur in conditioning a signal. **(10 Marks)**

b. Explain how high voltages and wrong polarity may be protected against, by the use of a zener diode circuit. **(06 Marks)**

c. Define filtering. Mention the four different types of filters. **(04 Marks)**

PART – B

5 a. Explain the evolution of microprocessors. **(07 Marks)**

b. With the truth table, for two inputs explain : i) AND – gate ii) OR – gate. **(08 Marks)**

c. Discuss the XOR – gate and write down its truth table. **(05 Marks)**

6 a. Explain for a microprocessor, the role of accumulator register and program counter register. **(08 Marks)**

b. State any four differences betweena microprocessor and a microcontroller. **(04 Marks)**

c. Write short notes on 'BUS' related to 8085 – microprocessor. **(08 Marks)**

7 a. Explain the commonly used instructions that may be given to a microprocessor under i) Data transfer ii) Arthmetic. **(10 Marks)**

b. With a flow chart, develop a program for the addition of two 8-bit numbers located in different memory addresses and storage of the result back into memory. **(10 Marks)**

8 a. List the four operations commonly performed by a CPU. **(04 Marks)**

b. Explain the terms : synchronous and asynchronous data transmission. **(06 Marks)**

c. Explain the five different conditions, under which, microprocessor controlled data transfer can takes place. **(10 Marks)**

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06M

Sixth Semester B.E. Degree Examination, May/June 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 handbook is permitted.

PART – A

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

b. Derive the general three-dimensional conduction equation in Cartesian coordinates and state the assumptions made. **(08 Marks)**

c. A composite wall is made up of three layers of thicknesses 25 cm, 10 cm and 15 cm of material A, B and C respectively. The thermal conductivities of A and B are 1.7 W/mK and 9.5 W/mK respectively. The outside surface is exposed to air at 20°C with convection coefficient of 15 W/m^2K and the inside is exposed to gases at 1200°C with a convection coefficient of 28 W/m^2K and the inside surface is at 1080°C. Determine the unknown thermal conductivity of layer made up of material C. **(06 Marks)**

2 a. It is desired to increase the heat dissipation over the surface of an electronic device of spherical shape of 5mm radius exposed to convection with h = 10 W/m^2K by encasing it in a transparent spherical sheath of K = 0.04 W/mK. Determine the diameter of the sheath for maximum heat flow. For a temperature drop of 120°C from the device surface, determine the heat flow for bare and sheathed device. **(10 Marks)**

b. A rod (K = 200 W/mK) 5mm in diameter and 5cm long has its one end maintained at 100°C. The surface of the rod is exposed to ambient air at 25°C with convection heat transfer coefficient of 100 W/m^2K. Assuming other end insulated, determine

i) The temperature of the rod at 20mm distance from the end at 100°C.
ii) Heat dissipation rate from the surface of the rod and
iii) Effectiveness. **(10 Marks)**

3 a. A thermocouple junction, which may be approximated as a sphere, is to be used for temperature measurement in a gas stream. The convection coefficient between the junction surface and the gas is 400 W/m^2K and the junction thermophysical properties are K = 20 W/mK, C_p = 400 J/kgK, ρ = 8500 kg/m^3. Determine the junction diameter needed for the thermocouple to have a time constant of 1 s. If the junction is at25°C and is placed in a gas stream that is at 200°C, how long will it take for the junction to reach 199°C? **(10 Marks)**

b. A large slab of wrought iron is at a uniform temperature of 375°C. The temperature of one surface of this slab is suddenly changed to 75°C. Calculate the time required for the temperature to reach 275°C at a depth of 5 cm from the surface and the quantity of energy transferred per unit area of the surface during this period. Take K = 60 W/mK and $\alpha = 1.626 \times 10^{-5}$ m^2/s. **(10 Marks)**

4 a. With reference to fluid flow over a flat plate, discuss the concept of velocity boundary layer and thermal boundary layer, with necessary sketches. **(05 Marks)**

b. Air at 20°C flows over both sides of a surface of a flat plate measuring 0.2m×0.2m. The drag force was 0.075 N. Determine the velocity gradient at the surface if kinematic viscosity has a value of 15.06×10^{-6} m^2/s and density = 1.205 kg/m^3. Also determine the drag coefficient, if the free stream velocity is 40 m/s. **(07 Marks)**

c. A horizontal plate 1 m×0.8 m is kept in a water tank, with the top surface at 60°C providing heat to warm stagnant water at 20°C. Determine the value of convection coefficient. Repeat the problem for heating on bottom surface. **(08 Marks)**

PART – B

5 a. Air at 20°C and 1 atm flows over a flat plate at 35 m/s. The plate is 75 cm long and is maintained at 60°C. Assuming unit depth in the z-direction, calculate the heat transfer from the plate. **(08 Marks)**

b. Air at 2 atm and 200°C is heated as it flows through a tube with a diameter of 25 mm at a velocity of 10 m/s. Calculate the heat transfer per unit length of tube if a constant heat flux condition is maintained at the wall and the wall temperature is 20°C above the air temperature all along the length of the tube. How much would the bulk temperature increase over a 3 m length of the tube? **(12 Marks)**

6 a. Derive an expression for LMTD of a parallel flow heat exchanger. State the assumptions made. **(08 Marks)**

b. Water to water heat exchanger of a counter flow arrangement has heating surface area of $2m^2$. Mass flow rates of hot and cold fluids are 2000 kg/hr and 1500 kg/hr respectively. Temperatures of hot and cold fluids at inlet are 85°C and 25°C respectively. Determine the amount of heat transferred from hot to cold water and their temperatures at the exit if the overall heat transfer coefficient U = 1400 W/m^2K. **(12 Marks)**

7 a. Distinguish between the nucleate boiling and film boiling. **(06 Marks)**

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

c. A vertical plate 30cm×30cm, is exposed to steam at atmospheric pressure. The plate temperature is 98°C. Calculate the heat transfer and the mass of steam condensed per hour. **(10 Marks)**

8 a. With reference to thermal radiation, explain the following terms:
i) Black body and gray body ii) Specular and diffuse surface iii) Radiosity and irradiation. **(06 Marks)**

b. Two parallel black plates 0.5m×1m are spaced 0.5m apart. One plate is maintained at 1000°C and the other at 500°C. What is the net radiant heat exchange between the two plates? **(06 Marks)**

c. Two very large parallel planes, with emissivities 0.3 and 0.8 exchange heat. Find the percentage reduction in heat transfer when a polished aluminium radiation shield ($\epsilon = 0.04$) is placed between them. **(08 Marks)**

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06ME661

Sixth Semester B.E. Degree Examination, May/June 2010
Theory of Elasticity

Time: 3 hrs. Max. Marks:100

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

PART – A

1 a. Derive the equations of equilibrium for a 3-D stress state. **(10 Marks)**

b. A point P in a body is given by

$$Z = \begin{bmatrix} 100 & 100 & 100 \\ 100 & -50 & 100 \\ 100 & 100 & -50 \end{bmatrix} mN/mm^2$$

Determine the total stress, normal stress and shear stress on a plane which is equally inclined to all the three axes. **(10 Marks)**

2 a. What is meant by stress invariants? With a sketch show that stress invariants are the same. **(10 Marks)**

b. The state of stress at a point is characterized by

$$Z = \begin{bmatrix} 12 & 3 & 0 \\ 3 & 4 & 0 \\ 0 & 0 & 10 \end{bmatrix} MPa.$$

Determine the principle stresses and directions for any principal stress. **(10 Marks)**

3 a. Derive the compatibility relation of strain in a 3-D elastic body. What is its significance? **(10 Marks)**

b. The state of stress at a point is given by

$\sigma_x = 200$ MPa ; $\sigma_y = -100$ MPa and $\sigma_z = 50$ MPa

$\tau_{xy} = 40$ MPa ; $\tau_{yz} = 50$ MPa and $\tau_{zx} = 60$ MPa.

If $E = 2 \times 10^{+5}$ N/mm^2 and $G = 0.8 \times 10^5$ N/mm^2. Find out the corresponding strain components from Hook's law. Take $\gamma = 0.2$. **(10 Marks)**

4 a. Show that $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)(\sigma_x + \sigma_y) = 0$ for a 2-D elastic body. **(10 Marks)**

b. What is stress function (ϕ)? Show that $\nabla \overset{\uparrow}{\phi} = 0$. **(10 Marks)**

PART – B

5 a. Derive the stress components for a plate with circular hole subjected to an uniazxial load. **(10 Marks)**

b. Derive the equilibrium equation in cylindrical coordinates for 2-D elastic body. **(10 Marks)**

6 a. Starting from the fundamentals derive the expression for hoop and radial stresses for a rotating hollow disc. **(10 Marks)**

b. Show that $M_t = GJ\theta$ in torsion of shafts with usual notations. Where G – modulus of rightly J – polar moment of inertia and θ - angular twist for unit length. **(10 Marks)**

7 a. Write the thermo elastic stress-strain relationships for 3-D elastic body. **(10 Marks)**

b. Derive the thermal stresses in a thin circular disc. **(10 Marks)**

8 Write a short notes on : a. Saint –Venants principle c. Principle of super –position
b. Plane stress and plane strain d. Membrane analogy. **(20 Marks)**

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Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

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06ME666

Sixth Semester B.E. Degree Examination, May/June 2010
Statistical Quality Control

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. Use of SQC tables is permitted.

PART – A

1 a. What are the benefits of statistical quality control? **(05 Marks)**

b. Define TQM. Explain how TQM can be ensured. **(05 Marks)**

c. State the various stages which are needed to be controlled for ensuring proper quality of product and for ensuring improvement in quality. **(10 Marks)**

2 a. Explain the normal distribution curve. **(05 Marks)**

b. Explain the relationship between mean and standard deviation. **(05 Marks)**

c. A machine shop produces steel pins. The width of 100 pins was checked after machining and data was recorded as follows:

Width (mm)	Frequency	Width (mm)	Frequency
9.50 – 9.51	6	9.58 – 9.59	22
9.52 – 9.53	2	9.60 – 9.61	8
9.54 – 9.55	20	9.62 – 9.63	6
9.56 – 9.57	32	9.64 – 9.65	4

i) Find the arithmetic mean, standard deviation and variance.

ii) What percentage of the pins manufactured have width from 9.52 to 9.63? **(10 Marks)**

3 a. Explain the analysis of patterns on control charts. **(10 Marks)**

b. Differentiate between the chance causes and assignable causes of variation giving suitable examples. **(05 Marks)**

c. Explain the significance of control chart. **(05 Marks)**

4 a. Explain the limitations of X and R chart. **(05 Marks)**

b. Explain type I and type II errors. **(05 Marks)**

c. The following table show the averages and ranges of the spindle diameters in mm for 30 subgroups of 5 items each:

$\bar{X}$	R	$\bar{X}$	R	$\bar{X}$	R
45.020	0.375	45.600	0.275	45.260	0.150
44.950	0.450	45.020	0.175	45.650	0.200
45.480	0.450	45.320	0.200	45.620	0.400
45.320	0.150	45.560	0.425	45.480	0.225
45.280	0.200	45.140	0.250	45.380	0.125
45.820	0.250	45.620	0.375	45.660	0.350
45.580	0.275	45.800	0.475	45.460	0.225
45.400	0.475	45.500	0.200	45.640	0.375
45.660	0.475	45.780	0.275	45.390	0.650
45.680	0.275	45.640	0.225	45.290	0.350

Estimate the values of $\bar{\bar{X}}$, $\bar{R}$ and σ. Evaluate the process capability. **(10 Marks)**

PART – B

5 a. What is meant by process capability? How will you determine the same? **(05 Marks)**

b. Explain the term process capability index C_{pk} and process performance index. **(05 Marks)**

c. A certain product has been statistically controlled at a process average of 36.0 and a standard deviation of 1.00. The product is presently being sold to two users who have different specification requirements. User A has established a specification of 38.0 ± 4.0 for the product and user B has specification of 36.0 ± 4.0.

i) Based on present process set up, what percent of the product produced will not meet the specifications of user A?

ii) What percent of the product will not meet the specifications of user B?

iii) Assuming that the two users' needs are equal, a suggestion is made to shift the process target to 37.0. At this suggested value, what percent of the product will not meet the specifications of user A?

iv) At the suggested process target, what percent of the product will not meet the specifications of user B?

v) Do you think this shift to a process target of 37.0 would be desirable? Justify. **(10 Marks)**

6 a. Explain the binomial distribution and Poisson distribution from the point of view of quality control. **(10 Marks)**

b. An item is made in lots of 200 each. The lots are given 100% inspection. The record sheet for the first 25 lots inspected showed that a total of 75 items were defective.

i) Determine the trial control limits for n – p chart showing the number of defectives in each lot.

ii) Assume that all points fall within the control limits. What is your estimate of the process average fraction defective p′ ?

iii) If this p′ remains unchanged, what is the probability that the 26^{th} lot will contain exactly 7 defectives? That it will contain 7 or more defectives? **(10 Marks)**

7 a. State and explain the advantages and limitations of acceptance sampling over 100% inspection. **(10 Marks)**

b. Explain the characteristics of OC curve. **(10 Marks)**

8 a. Give a brief account of CUSUM control chart and basic principles of the chart for monitoring the process mean. **(10 Marks)**

b. List all the elements required to design an EWMA control chart. **(10 Marks)**

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