Code No: RR321401 **Set No. 1**

III B.Tech II Semester Regular Examinations, Apr/May 2006
PRINCIPLES OF MACHINE DESIGN
(Mechatronics)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What are the assumptions made in the theory of pure bending?
   (b) A Steel saw blade 1mm thick is bent into an arc of circle 500mm radius. Determine flexural stress induced and the bending moment required to bend the blade, which is 15mm wide. Take E = 210000 MPa. [4+12]

2. A pulley is keyed to shaft mid-way between two antifriction bearings. The bending moment at the pulley varies from 150N-m CW to 450N-m CCW as the torsional moment in the shaft varies from 50 to 150MPa. The shaft is made of cold drawn steel having an ultimate strength of 560MPa and yield strength of 400MPa. The frequency of the variation of the required diameters of the shaft for an indefinite life. The stress concentration factors for the keyway in the bending and torsion may be taken as 1.7 and 1.4 respectively. Use design factor of 1.8.Design the shaft. [16]

3. (a) What are the rolling contact bearings? Discuss their advantages over sliding contact bearings.
   (b) Write short note on different types of antifriction bearings. [8+8]

4. Two 35 mm shafts are connected by a flanged coupling. The flanges are fitted with bolts on 125 mm bolt circle, the shafts transmit a torque of 800 N-m at 350 rpm. For the safe stresses mentioned below. Calculate
   (a) Diameter of bolts
   (b) Thickness of flanges
   (c) Key dimensions
   (d) Hub length and
   (e) Power transmitted

   Safe shear stress for shaft material = 63 MPa
   Safe stress for bolt material = 56 MPa
   Safe stress for cast iron coupling = 10 MPa
   Safe stress for key material = 46 MPa. [3+3+3+3+4]

5. A machine component is subjected to a flexural stress which fluctuates between ± 300 MN/m^2. Determine the value of minimum ultimate strength according to
   (a) Gerber relation;
   (b) Modified Goodman relation;

(c) Soderberg relation.

Take yield strength = 0.55 Ultimate strength; Endurance strength = 0.5 Ultimate strength; and factor of safety = 2. [5+5+6]

6. Design and draw a trunk type of piston for a single cylinder four-stroke diesel engine running at 1000 rpm. Other data available are:

Maximum explosion pressure	= 3.5 MN/m^2
Mean effective pressure	= 0.65 MN/m^2
Diameter of piston	= 150 mm
Stroke length	= 200 mm
Connecting rod length	= 450 mm
bsfc	= 0.27 kg/kWh

[12+4=16]

7. A 50 kW motor running at 1000 rpm. is required to drive a pump pulley at 400 rpm. Motor pulley diameter is limited to 0.3 m. Center distance is to be around 2.5 m. Select a suitable V-belt and design the drive. [16]

8. Design a pair of spur gears to drive a lobe-blower from a 120 kW motor running at 2880 rpm. With a reduction ratio of 1.6. The pitch diameter of the pinion is not to be more than 80 mm. Drive is an enclosed one with proper lubrication. Life to be indefinite. Light shock loads are likely. [16]

Name	Material (Steel)	Design compressive stress (N/mm^2)	Design bending stress (N/mm^2)
Pinion	CI 35	600	550
Gear	CI 25	600	400

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Code No: RR321401 **Set No. 2**

III B.Tech II Semester Regular Examinations, Apr/May 2006
PRINCIPLES OF MACHINE DESIGN
(Mechatronics)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. A bolt subjected to a direct tensile load of 20kN and shear load of 15kN. Suggest the bolt according to maximum shear stress theory, Distortion energy theory and maximum principal stress theories of failures, if the yield stress in simple tension is 360MPa. A factor of safety of 3 should be used. Take Poissons ratio as 0.25. [5+5+6=16]

2. A solid steel shaft is supported on two bearings 1.8m apart and rotates at 250 rpm. A 20^o involute gear D, 300mm diameter is keyed to the shaft at a distance of 150mm to the left of the right hand bearing. Two pulleys B and C are located on the shaft at distances of 600mm and 1350mm respectively. 30kWis supplied to the gear, out of which 18kW is taken off at the pulley C and 12kW from pulley B. The drive from B is vertically downward while from C the drive is downward at an angle of 60o to the horizontal. In both cases the belt tension ratio is 2 and the angle of lap is 180o. The combined fatigue and shock factors for tension and bending may be taken as 1.5 and 2 respectively. Design a suitable shaft taking working stress to be 42 MPa in shear and 84Mpa in tension. [16]

3. Design a bearing and journal to support a load of 6KN at 800 rpm using a hardened steel journal and bronze backed babbit bearing. An abundance of oil having a viscosity of 250 Stokes saybolt at 37.8^oC and a specific gravity of 0.90 at 15^oC is provided. The bearing is relieved for 20^o from the normal to the load line. Assume an oil temperature of 82^oC and a clearance of 0.0015 mm per mm of diameter. The bearing modulus for this type of bearing is about $48.3X10^{-6}$. [16]

4. Design a bushed-pin type flexible coupling for connecting a motor shaft to a pump shaft for the following service conditions.
   Power to be transmitted = 40 kW;
   speed of the motor shaft = 1000 rpm;
   diameter of the motor shaft = 50 mm;
   diameter of the pump shaft = 45 mm
   The bearing pressure in the rubber bush and allowable stress in the pins are to be limited to 0.45 N/mm^2 and 25 MPa respectively. [16]

5. A hot rolled steel shaft is subjected to a torsional moment that varies from 330 N-m clockwise to 110 N-m counterclockwise and an applied bending moment at a critical section varies from 440 N-m to -220 N-m. The shaft is of uniform cross-section and no keyway is present at the critical section. Determine the required shaft diameter. The material has an ultimate strength of 550 MN/m^2 and a yield

strength of 410 MN/m^2. Take the endurance limit as half the ultimate strength, factor of safety of 2, size factor of 0.85 and a surface finish factor of 0.62. [16]

6. Design and draw a trunk type of piston for a single cylinder four-stroke diesel engine running at 1000 rpm. Other data available are:

Maximum explosion pressure	= 3.5 MN/m^2
Mean effective pressure	= 0.65 MN/m^2
Diameter of piston	= 150 mm
Stroke length	= 200 mm
Connecting rod length	= 450 mm
bsfc	= 0.27 kg/kWh

[12+4=16]

7. A 50 kW, 1160 rpm. AC split phase motor is to be used to drive a reciprocating pump at a speed of 330 rpm. The pump is for 12 hours service and normally requires 44 kW, but is subjected to peak loads of 175% of full load. Determine the details of multiple V-belt drive for this application. [16]

8. A spur gear drive is used to drive a camshaft by the crankshaft with a speed reduction of 2 in a 5 kW engine. The center distance is to be not more than 160 mm. Design the drive for 10,000 hours. Crankshaft speed is 1500 rpm. Assume pinion, gear are C 15 steel and cast iron grade 30, pressure angle 20^0, Design compressive stress for pinion, gear are 772 N/mm^2, 350 N/mm^2, design bending stresses for pinion, gear are 85 N/mm^2, 55 N/mm^2. [16]

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Code No: RR321401 **Set No. 3**

III B.Tech II Semester Regular Examinations, Apr/May 2006
PRINCIPLES OF MACHINE DESIGN
(Mechatronics)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What are the assumptions made in the theory of pure bending?
   (b) A Steel saw blade 1mm thick is bent into an arc of circle 500mm radius. Determine flexural stress induced and the bending moment required to bend the blade, which is 15mm wide. Take E = 210000 MPa. [4+12]

2. (a) "Square key is equally strong in shear and compression" justify the statement.?
   (b) A propeller is fastened by means of a sunk key to the shaft subjected to torsion only. Find the ratio of sectional areas of the shaft and key for equality of strength of the key and shaft. Find the length of key 20mm wide for a shaft 70mm in diameter; take allowable shear stresses for the key and the shaft as 55 and 65MPa respectively. [8+8]

3. (a) What are the rolling contact bearings? Discuss their advantages over sliding contact bearings.
   (b) Write short note on different types of antifriction bearings. [8+8]

4. Design a bushed-pin type flexible coupling for connecting a motor shaft to a pump shaft for the following service conditions.
   Power to be transmitted = 40 kW;
   speed of the motor shaft = 1000 rpm;
   diameter of the motor shaft = 50 mm;
   diameter of the pump shaft = 45 mm
   The bearing pressure in the rubber bush and allowable stress in the pins are to be limited to 0.45 N/mm^2 and 25 MPa respectively. [16]

5. A shaft is subjected to a bending moment varying from +300 N-m to -600 N-m;a torque varying from -50 N-m to +50 N-m and an axial load varying from -5kN to +10 kN. The shaft is machined from 40 C8 steel. Find the diameter of the shaft, if its surface is rough finished. [16]

6. Design and draw a trunk type of piston for a single cylinder four-stroke diesel engine running at 1000 rpm. Other data available are:

Maximum explosion pressure	= 3.5 MN/m^2
Mean effective pressure	= 0.65 MN/m^2
Diameter of piston	= 150 mm
Stroke length	= 200 mm
Connecting rod length	= 450 mm
bsfc	= 0.27 kg/kWh

[12+4=16]

7. A V-belt drive is to transmit 15 kW to a compressor. The motor runs at 1150 rpm and the compressor is to run at 400 rpm. Determine the size and the number of belts required. [16]

8. Calculate the power that can be transmitted safely by a pair of spur gears with the data given below. Calculate also the bending stresses induced in the two wheels when the pair transmits this power. [8+7+4=16]

No. of teeth in the pinion	= 20
No. of teeth in the gear	= 80
Module	= 4 mm
Width of teeth	=60 mm
Tooth profile	= 20^0 in volute
Allowable bending strength of the material	
	= 200 MPa, for pinion
	=160 MPa, for gear
Speed of the pinion	= 400 rpm
Service factor	= 0.8
Lewis from factor	$= 0.154 - \frac{0.912}{T}$

Velocity factor $= \frac{3}{3+v}$

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Code No: RR321401 **Set No. 4**

III B.Tech II Semester Regular Examinations, Apr/May 2006
PRINCIPLES OF MACHINE DESIGN
(Mechatronics)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) List the factors required to be taken into account for the selection of materials. [8]

   (b) Define the following terms:
   i. Ductility
   ii. Malleability
   iii. Brittleness
   iv. Resilience [4x2=8]

2. A cast gear wheel is driven by a pinion and transmits 100 kW at 375 rpm. The gear has 200 machine cut teeth having 20^0 pressure angle and is mounted at the center of a 0.4 m long shaft. The gear weights 2000 N and its pitch circle diameter is 1.2 m. Design the gear shaft. Assume that the axes of the gear and pinion lie in the same horizontal plane. [16]

3. Select a suitable spherical roller bearing from SKF series 222C to support a radial load of 4 kN and an axial load of 2 kN. Minimum life required is 10,000 hours at 1000 rpm. For the selected bearing find.
   (a) The expected life under the given loads.
   (b) The equivalent load that can be supported for a life of 10000 hours.
   (c) The load that can be supported with a probability of survival of 95% with 10,000 hours. [5+5+6]

4. Design and draw a sleeve or muff coupling which is used to connect two steel shaft transmitting 35 kW at 330 rpm. Choose your own values for permissible stresses. [12+4=16]

5. A Circular bar of 500 mm length is supported freely at its two ends. It is acted upon by a central concentrated cyclic load having a minimum value of 20 kN and a maximum value of 50 kN. Determine the diameter of bar by taking a factor of safety of 1.5, size effect of 0.85, surface finish factor of 0.9. The material properties of bar are given by: ultimate strength of 650 MPa, yield strength of 500 MPa and endurance strength of 350 MPa. [16]

6. Design a connecting rod for a petrol engine from the following data:

Diameter of the piston	= 120 mm
Weight of the reciprocating part	= 2.0 kg
Length of the connecting rod	= 300 mm

Stroke length	= 140 mm	
Speed	= 2000 rpm	
Maximum explosion pressure	= 2.25 N/mm^2	[16]

7. A V-belt drive is to transmit 15 kW to a compressor. The motor runs at 1150 rpm and the compressor is to run at 400 rpm. Determine the size and the number of belts required. [16]

8. A micarta pinion rotating 1200 rpm is to transmit 1 kW to a cast iron gear at a speed of 192 rpm. Assuming a starting overload of 20% and using 20^0 full depth involute teeth, determine the module, number of the teeth on the pinion and gear and face width. Take allowable static strength of micarta as 40 MPa and for cast iron as 53 MPa. Check the pair in wear. [3+3+3+3+2+2]

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