Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. Sem. – IInd - Examination – June/July- 2011

Subject code: 1720903

Subject Name: Machine Tool Design

Date:27/06/2011 **Time: 10:30 am – 01:00 pm**

Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** A lathe is subjected to a 160 kg vertical force(F_z), and a 50 kg horizontal force (F_y), at the cutting point on the 200 mm diameter work piece. Design a "V and Flat" combination guide way, if the saddle length (L) is 100 mm. Height of the spindle center above the flat guide way is 150 mm and saddle weight is 35 kg. **07**

Assume $\alpha = 60°$ and $\beta=30°$

For cast iron to cast iron slideway, the recommended pressure = 0.125 kg/mm^2.

(b) What are the major design requirements for a guide ways? Derive the equation for forces acting on the mating surfaces in a combination of V and Flat slideways.(orthogonal cutting condition) **07**

Q.2 **(a)** Find the tool radial displacement for (a) 2 flatways and (b) one flatway one veeway combination guideways, if **07**

Distance between centerlines of guideways =200 mm

spindle center height = 150 mm

Pressure on guideway face A (P_A) = 0.12 kg/mm^2

Pressure on guideway face B(P_B) = 0.15 kg/mm^2

Pressure on guideway C (P_C) = - 0.08 kg/mm^2

Assume $\alpha = 60°$ and $\beta=30°$.

Find the rigidity, if F_Z , downward forces on slideway = 160 kg and F_y, Forces in the direction perpendicular to the guideways = 110 kg. Guideway thickness = 25 mm and saddle length = 100 mm.

(b) Explain the procedure for selection of motor in machine tool that works under (a) constant loading condition & (b) variable loading condition. **07**

OR

(b) What are the factors affecting the stiffness of machine tool structure and suggest the methods of improving the stiffness of machine tool structure. **07**

Q.3 **(a)** Derive the following relationship between the actual parameter and its value determined on the model, helpful in model technique in design of machine tool structure: **07**

(a) Relationship for bending stiffness of structure.

(b) Relationship for natural frequency of torsional vibration.

(b) For a lathe bed, derive an equation for bending rigidity of diagonally ribbed bed and comment on the parameters influencing the bending rigidity. **07**

OR

Q.3 **(a)** [1] Design a rectangular MS table of 400 X 700 mm size and calculate the stiffness coefficient. Take E= 2.1 X 10^4 kg/mm^2 **04**

[2] Design a 700 mm diameter circular table with 0.0001mm/kg stiffness. Take E= 2.1 X 10^4 kg/mm^2. **03**

(b) For a lathe bed, derive an equation for torsional rigidity of diagonally ribbed bed and comment on the parameters influencing the torsional rigidity. **07**

Q.4 **(a)** Find the spindle diameters for the overhanging part, and the part between the anti-friction bearings, for the spindle as shown in fig. 1. The spindle is powered by a 2.5 kw motor, running at an rpm ranging from 400 to 2400. The spindle is mounted with a gear at 60 mm from the rear bearing (P). It has 80 teeth of 1.5 modules. The gear generates a radial separating force of 101 kgf. The spindle is subjected to fluctuating load. Determine the deflection at the gear, and the overhanging end. Check the slopes for the limit of 0.001 radians. The spindle run out should not exceed 0.02 TIR (Total Indicated Run out). The reactive bending moment can be taken as 10 % of the bending moment, due to the overhanging load (M_Q). Permissible bending stress f_b = 4.5 kgf/mm^2 and δ_g = 0.01.E =2.1 X 10^4 kg/mm^2. **07**

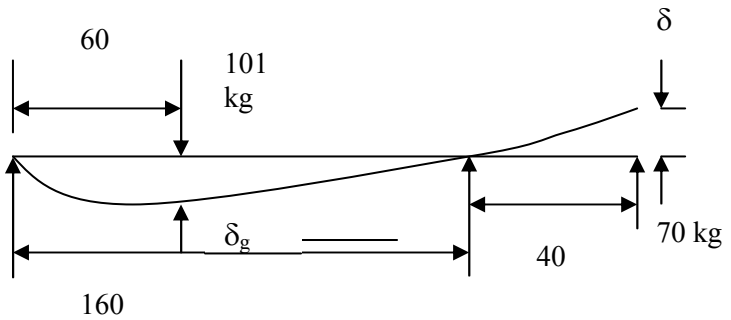

Figure :1

(b) Find the load capacity of a 35 X 20 (diameter X length) bearing, IF RPM =2200. Oil dynamic viscosity(η) = 7 X 10^{-9} kgf.sec/mm^2. Bearing bore is finished to Ra = 0.4 microns, while the journal diameter finish is Ra = 0.2 microns.ψ = 0.001 and deflection of bearing edge (δ) =0.005. For l /d=0.6 and X=0.46 Take ϕ = 0.706. **07**

OR

Q.4 **(a)** The spindle of a high precision machine is subjected to 200 kgf overhung load at 60 mm from the nearest bearing. It is subjected to 50 kgf load at mid span, between the anti friction bearings. Find the spindle diameters in the overhung portion (D_A), and between the bearings (D_L) to optimize the span(L). The spindle is transmitting 5 kw at 110 rpm. It is subjected to a fluctuating load. The deflection between the bearings should be limited to 0.03.Permissible bending stress f_b = 6 kgf/mm^2. For precision machine, λ=0.1 and D_L = D_A = 40 mm. What are the practical consideration to determine span of the bearings.? **07**

(b) How can one find the optimum spacing between spindle supports (λopt) so as to ensure minimum total deflection of spindle and what are the parameters on which (λopt) depends upon? **07**

While turning a 750 mm long workpiece of 100 mm diameter between centers , the radial cutting force was found to be 150 kgf when the tool was 200 mm from the tailstock. Calculate the machine tool and system compliance, if the stiffness of the saddle, headstock and tailstock is 3000, 4000 and 2500 kgf/mm respectively.

Q.5 **(a)** Derive the equation for total deflection of spindle axis due to compliance of spindle supports. **07**

(b) What do you mean by preselective control system? Explain preselective control system with a typical example. **07**

OR

Q.5 **(a)** What do you mean by selective control system? Explain with a typical example how speed & feed changing system can be done with selective control. **07**

(b) [1] Find the load capacity and rigidity of a guideway, if slideway width (B)= 40 mm , pitch of groove (L) = 40 mm. Pump pressure = 150 kg/cm^2 , oil groove pressure = 100 kg/cm^2. Oil film thickness (h) = 0.015. **04**

[2] Find the load capacity of two hydraulic wedges, if the overall length of wedge (L) = 200 mm, sliding velocity (v) = 20 meter/min, wedge width (W_w) =160 mm, film on flat land (h_1) = 0.015 mm, μ = 4 X 10^{-9} kg sec/mm^2. **03**

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