

Mech. Engg. Deptt.  
INDIAN INSTITUTE OF TECHNOLOGY DELHI  
Major Test - 1st Semester 2006-07  
**MEL 737: ADVANCED MECHANICAL ENGINEERING DESIGN**  
on 27.11.2006 (Monday) at 8:00-10:00 hrs in III 336  
Course Coordinator/Faculty : Prof. T.K.Kundra/ Prof K.Athre

**Max. Marks 120**

**Notes:** 1. *Attempt Part A and Part B on separate answer books*  
2. *"Machine Design" by R.L.Norton is permitted for reference.*

**Part A**

- 1[a] How would you approach a mechanical engineering problem for getting feasible and optimal designs? For illustrating your strategy assume the problem of power transmission in a machine.
- [b] Formulate constraints for ensuring ~~ensuring~~ sound dynamic design of shafting and helical springs. How is dynamic design approached currently?
- [c] Illustrate the principles of initial estimation of configuration with the example of power transmitting spur gears. Quantify the constraints also for such a problem. (7,8,10)
- 2 [a] A three shift duty machine tool component modelled like a simply supported shafting is proposed to be made from C45 steel, having a diameter of 30mm. A transverse hole of 4mm diameter at the centre of the shaft is provided to meet assembly requirements. Values of Axial load, Bending moment and Torsion during the life time are estimated to vary as 1000-20000 N, 15-200 Nm and 100-350 Nm respectively. Desired FOS with von Mises analysis is 3. Predict the safety of the component.
- [b] Suggest a suitable bearing for the above shafting if the distance between the supports is 300 mm. (20,15)

**Part B**

3. A direct tension member is made of martensitic steel. It has a rectangular net cross section of 8.75 mm by 36 mm wide. It has a semicircular edge notch. The tension member is continued to be subjected to a completely reversed cyclic axial force of 80 kN following the initiation of a fatigue crack. It may be assumed that the length of a newly initiated fatigue crack (initial crack length) is 1.25 mm. Further it may be assumed that the stress concentration affects are negligible for the propagating crack (since the initiated crack tip probably extends through most of the zone of stress concentration). Find the maximum acceptable final crack length and therefore how many cycles of continued loading would you estimate (based on fracture mechanics approach) could be applied before catastrophic fracture would occur. Assume the following data for martensitic steel:  $S_{yt} = 1400$  MPa,  $K_c = 82$  MPa-m<sup>0.5</sup> (15)
4. A cam-follower system has a dynamic load of 0 to 2 kN. The cam is cylindrical with a minimum radius of curvature of 20 mm. The roller follower is crowned with radii of 15 mm in one direction and 150 mm in the other. Find the contact stresses and safety factor if the follower is 4150 steel at HB300 with  $S_{fc}' = 1500$  MPa and the cam is nodular iron at HB207. They run lubricated with less than 1% slip. (35)
5. Estimate the depth of wear expected from AISI 1030 (C-30) steel shaft of 40mm diameter rotating at 250 rpm three 8 hour shifts per day for 10 years (each of 360 days) in a plain bronze bushing, if transverse load is 1000 N. Assume poor condition of lubrication. (10)