

# COLLEGE OF ENGINEERING, PUNE

(An Autonomous Institute of Government of Maharashtra.)  
SHIVAJI NAGAR, PUNE - 411 005

## END Semester Examination

### (PR-5203) Principles of Design of Machine Elements

Course: M.Tech

Branch: Mechatronics

Semester: Sem I

Year: 2014-2015

Max.Marks:60

Duration: 3 Hours Time:- 2 pm to 5 pm

Date:22/11/2014

#### Instructions:

MIS No.

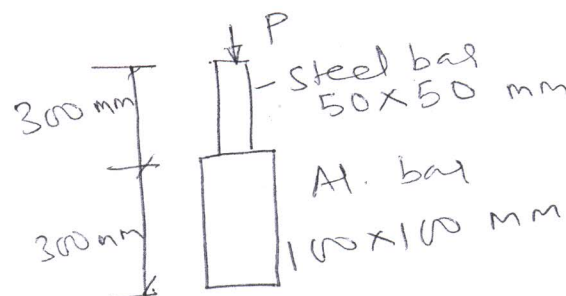
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1. Solve any six questions.
2. Mobile phones and programmable calculators are strictly prohibited.
3. Writing anything on question paper is not allowed.
4. Exchange/Sharing of anything like stationery, calculator is not allowed.
5. Assume suitable data if necessary.
6. Write your MIS Number on Question Paper

Q.1 a) A horizontal beam 10 m long is carrying a uniformly distributed load of 1 KN/m. The beam is supported on two supports 6 m apart. Find the position of the supports, so that B.M on the beam is as small as possible. Also draw the shear force and bending moment diagram.

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Q.2 a) A member formed by connecting a steel bar to an aluminum bar is shown in Fig. Assuming that the bars are prevented from buckling sidewise, calculate the magnitude of force P, that will cause the total length of the member to decrease 0.25 mm. the values of elastic modulus for steel and aluminum are 210 KN/mm<sup>2</sup> and 70 KN/mm<sup>2</sup> respectively.



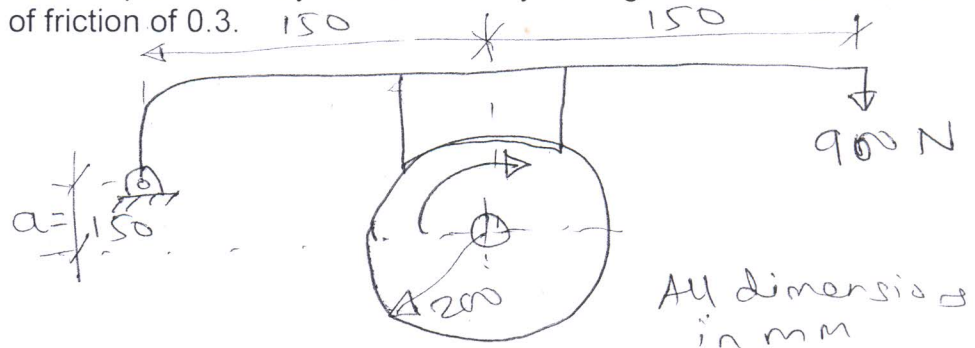
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b) A rectangular beam 300 mm deep simply supported over a span of 4 meters. What

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uniformly distributed load per meter the beam may carry, if the bending stress is not to exceed  $120 \text{ N/mm}^2$ ? Take  $I = 8 \times 10^6 \text{ mm}^4$ .

- Q.3 a) Determine the torque that may be resisted by a single block brake shown in Fig. for a coefficient of friction of 0.3.



- b) A single plate friction clutch has a friction surface having an outer diameter of 300 mm and an inner diameter of 200 mm. if the coefficient of friction is 0.3 and the axial force is 1 kN, determine the frictional torque capacity of the clutch based on uniform pressure and uniform wear theories.

- Q.4 a) Find the maximum torque, that can be applied safely to a shaft of 300 mm diameter. The permissible angle of twist is  $1.5^\circ$  in a length of 7.5 m length and the shear stress is not to exceed  $42 \text{ N/mm}^2$ . Take  $C = 84.4 \text{ kN/mm}^2$ .

- b) What is natural frequency?

Derive expression for natural frequency of free vibration of spring mass system. Find out the expression for displacement at any time  $t$ , during free oscillations?

- Q.5 A spur gear pair with reduction ratio 3:1 transmits 10 kW at 1400 r.p.m. Pinion has 25 teeth with  $14.5^\circ$  involute profile. The pinion and the gear are made of steel with safe stress  $250 \text{ Mpa}$ . The service factor is 1.3 and the starting torque is 30% higher than running torque the module is 6 mm. The value of  $y = 0.124 - (0.684/T)$ . Find out the surface hardness required to resist wear having equal strength in bending.

- Q.6 An electric motor running at 1500 r.p.m. drives a compressor which runs at 200 r.p.m. A helical cast steel gear with  $30^\circ$  helix angle has a module of 6 mm. The gear has face width. Three times normal pitch with  $20^\circ$  full depth involute profile. No of teeth on gear is 24. Allowable static stress is  $56 \text{ Mpa}$ . The profile tooth Factor is  $y = 0.154 - (0.912/T)$ . Estimate the power rating of electric motor, driving the compressor, if the service factor is 1.5.

- Q.7 A pair of straight bevel gears is mounted on shafts which are intersecting at right angles. The number of teeth on pinion and gear wheel is 21 and 28 respectively. The pressure angle is  $20^\circ$ . Pinion shaft is connected to an electric motor developing 5 kW, rated power at 1440 r.p.m. The service factor may be taken as 1.5. The pinion and the gear are made up of steel having ultimate strength of  $750 \text{ N/mm}^2$  and heat treated the surface to 3880BHN hardness. The gears are machined by manufacturing process that limits the error between meshing gear to 10 micron. The module and the face width are 4 mm and 20 mm respectively. The combined error for 4 mm module is 0.01 mm and deformation factor is  $11400 \text{ N/mm}^2$ . Determine the factor of safety for bending strength and wear strength. Value of  $Y = 0.34$ .