BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR
B.E. (Mech.) 8TH SEMESTER FINAL EXAMINATION, 2013

DESIGN OF MECHNICAL SYSTEMS (ME – 801)

Full Marks: 70 **Time: 3 hrs**

Use separate answer script for each half.
Answer FOUR questions, taking TWO from each half.
All questions carry equal marks.

FIRST HALF

1. A six-speed gear box drive is required to be designed for transmitting 15 KW with speeds ranging from 250 r.p.m. with preferred common ration $\phi = 1.40$.

   (a) Draw at least four ray diagrams and select the optimum one.

   (b) Find out the shaft diameters, number of teeth and module of all spur gears. Given that the materials of shaft and gear are recommended as C-30 steel (allowable shear stress = 50MPa) and alloyed steel (allowable yield stress = 220 MPa). Module is to be calculated on the basis of beam strength only.
   Assume that
   Lewis Form Factor for 20° fdi, $Y = \pi (0.154 - 0.912/Z)$,
   Service Factor = 1.5.

   (c) Draw a neat sketch for the layout of the gear box showing the minimum dimensions related to volume of the gear box.

2. A given mechanical stepless drive consists of a roller and a friction disc with the following particulars:

   Roller radius r =100mm, length of the roller & friction disc b = 50mm, radius of the friction disc making contact with the roller R = 160 mm, coefficient of friction between the roller and the friction disc $\mu = 0.35$, the compressive force of the spring required to ensure contact between the roller and the friction disc Q=1000N, speed of the driving roller = 500 r.p.m. If the torque transmitted in friction disc is 35 N-m, draw a complete diagram showing all the relevant elements and derive the expressions in finding the followings:

   (a) The radius of the friction disc at the no-slip point i.e. R′.
   (b) The speed of the friction disc and power loss in Watt.
   (c) Hertzian contact area and maximum hertzian contact stress, if equivalent modulus of elasticity is 110 GPa.

3. (a) Find the polynomial equation of displacement of a knife-edge follower as a function cam rotational angle for an advanced cam curve

Given boundary conditions:
When cam angle $\theta = 0$; displacement, velocity & acceleration of the follower are all zero. When Cam angle $\theta = \beta$; maximum rise of the follower = h and its velocity & acceleration are zero.

(b) The aforesaid cam-follower system has the following data:

Rise of follower, $h = 50$ mm, corresponding Cam rotational angle $\beta = 180°$, prime circle radius $r_o = 35$ mm, offset of the follower, $e = 10$ mm, Cam factor, $f = 3.80$, Cam shaft speed $N = 700$ rpm, follower weight $w = 25$ N, spring stiffness $k = 20$ N/mm, initial spring compression $y_i = 3$ mm

Determine displacement, velocity, acceleration & jerk of the knife-edge follower and pressure angle & torque transmission of the cam shaft at cam rotational angle of 90°.

Second Half

Answer any **two** questions

4. Design the connecting rod for a petrol engine for the following data: diameter of the piston (d) = 100 mm, length of the connecting rod (l) = 350 mm, stroke length (L) = 75 mm, engine speed (N) = 3000 rpm, maximum explosion pressure = 3.5 MPa and reciprocating mass = 2 kg. Assume suitable values of the missing data.

5. Answer the following questions:
   (a) What do you mean by complex stiffness?
   (b) What do you mean by apparent elastic modulus of metal-rubber bonded Isolator? Mention the factors that determine the apparent elastic modulus of metal-rubber bonded spring.
   (c) The rubber pads (shown as gray coloured) used in the construction of a bonded rubber spring of the type shown in Fig. 1 have a form factor $k_f = 0.54$. Given $G = 840 \times 10^3$ N/m^2, $h = 10$ cm, $\alpha = 61°$, cross-sectional area of each rubber pad is A=150 cm^2. Determine the vertical stiffness of the spring.
   (d) A 100 kg fan is to be mounted at four points on helical spring vibration isolators. The expected isolation efficiency is 97% at 3000 rpm. Estimate the required stiffness of the isolator springs.

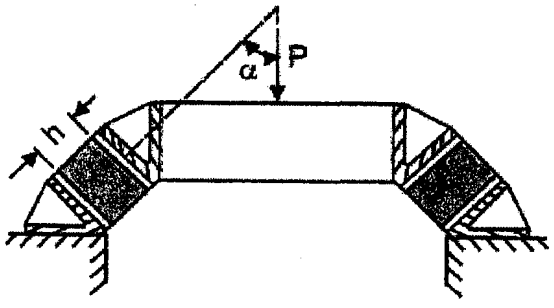

Figure 1

6. Design a plain carbon steel crankshaft for a 200 mm by 300 mm single acting, four stroke single cylinder engine to operate at 200 rpm. The mean effective pressure is 0.5 MPa and the maximum combustion pressure is 2.5 MPa. The maximum torsional moment is obtained at 35° crank angle and the corresponding gas pressure is 1.1 MPa. The ratio of the connecting rod to crank radius is 4. The flywheel is used as a pulley. The weight of the flywheel is 60 kN and the total horizontal belt pull is 6 kN. Assume suitable values of the missing data.