

# National Institute of Technology, Hamirpur (H.P.) 

## B. Tech, Mechanical Engineering End Semester Examination

Branch: Mechanical Engineering
Course Name: Dynamics of Machines
Time Allowed: 3 Hours

Semester: $4^{\text {th }}$
Course Code: ME-221
Maximum Marks: 50

NOTE: Attempt all the questions carrying marks as indicated.

1. What do you understand by Gyroscopic couple? Derive a formula for its magnitude. Explain in detail the application of gyroscopic principles to aircrafts
2. Define free vibration, forced vibration and damped vibration. How are the velocity and acceleration of the slider of a single slider crank chain determined analytically.
3. Briefly explain: (a) Hunting of Governor (b) Hammer Blow (c) Swaying couple
4. A multi-cylinder engine is to run at a speed of 600 r.p.m. On drawing the turning moment diagram to a scale of $1 \mathrm{~mm}=250 \mathrm{~N}-\mathrm{m}$ and $1 \mathrm{~mm}=3^{\circ}$, the areas above and below the mean torque line $\mathrm{in}_{\mathrm{mm}}{ }^{2}$ are : $+160,-172,+168,-191,+197,-162$. The speed is to be kept within $\pm 1 \%$ of the mean speed of the engine. Calculate the necessary moment of inertia of the flywheel. Determine the suitable dimensions of a rectangular flywheel rim if the breadth is twice its thickness. The density of the cast iron is 7250 $\mathrm{kg} / \mathrm{m}^{3}$ and its hoop stress is 6 MPa . Assume that the rim contributes $92 \%$ of the flywheel effect.
5. A shaft carries four masses A, B, C and D of magnitude $200 \mathrm{~kg}, 300 \mathrm{~kg}, 400 \mathrm{~kg}$ and 200 kg respectively and revolving at radii $80 \mathrm{~mm}, 70 \mathrm{~mm}, 60 \mathrm{~mm}$ and 80 mm in planes measured from A at $300 \mathrm{~mm}, 400 \mathrm{~mm}$ and 700 mm . The angles between the cranks measured anticlockwise are $A$ to $B 45^{\circ}$, B to $\mathrm{C} 70^{\circ}$ and C to $\mathrm{D} 120^{\circ}$. The balancing masses are to be placed in planes X and Y . The distance between the planes $A$ and $X$ is 100 mm , between $X$ and $Y$ is 400 mm and between $Y$ and $D$ is 200 mm . If the balancing masses revolve at a radius of 100 mm , find their magnitudes and angular positions using graphical method.
6. The arms of a Porter governor are 300 mm long. The upper arms are pivoted on the axis of rotation. The lower arms are attached to a sleeve at a distance of 40 mm from the axis of rotation. The mass of the load on the sleeve is 70 kg and the mass of each ball is 10 kg . Determine the equilibrium speed when the radius of rotation of the balls is 200 mm . If the friction is equivalent to a load of 20 N at the sleeve, what will be the range of speed for this position?
7. The three cylinders of an air compressor have their axes $120^{\circ}$ to one another, and their connecting rods are coupled to a single crank. The stroke is 100 mm and the length of each connecting rod is 150 mm . The mass of the reciprocating parts per cylinder is 1.5 kg . Find the maximum primary and secondary forces acting on the frame of the compressor when running at 3000 r.p.m. Describe clearly a method by which such forces may be balanced.
