(Answer all questions)

1) The following data refer to two meshing gears having 20° involute teeth. Number of teeth of gear wheel =52. Number of teeth on the pinion = 20, Speed of pinion = 360 r.p.m, Module = 8 mm. The addendum on each gear is such that the path of approach and path of recess are half of their maximum possible values. Determine the addendum of the gear and the pinion and length of arc of contact. **[10]**

2) An epicyclic gear train consists of a pinion B, a wheel A of 40 teeth and annulus C with 84 internal teeth concentric with the wheel. The pinion gears with the wheel and the annulus. The arm D that carries the axis of the pinion rotates at 100 r.p.m.
   a. If the annulus is fixed, find the speed of the wheel
   b. If the wheel is fixed, find the speed of the annulus. **[10]**

3) Synthesize a four link mechanism if the motions of the input and the output links are governed by a function $y = 2 \ln x$ and x varies from 2 to 12. Assume input angle θ to vary from 30° to 120° and output angle φ from 60° to 150°. Assume unit dimension for the fixed link. Use Chebychev spacing of accuracy points. Draw the mechanism. **[20]**

4) The turning moment diagram for a multi-cylinder engine has been drawn to a vertical scale of 1 mm = 4500 Nm and a horizontal scale of 1 mm = 2.4°. The areas above and below the mean torque line are 342, 23, 245, 303, 115, 232, 227, and 164 mm². If the mass of the flywheel is 1000 kg and the total fluctuation of speed does not exceed 3% of the mean speed, find the minimum value of radius of gyration. The speed of the engine is 150 rpm. **[10]**