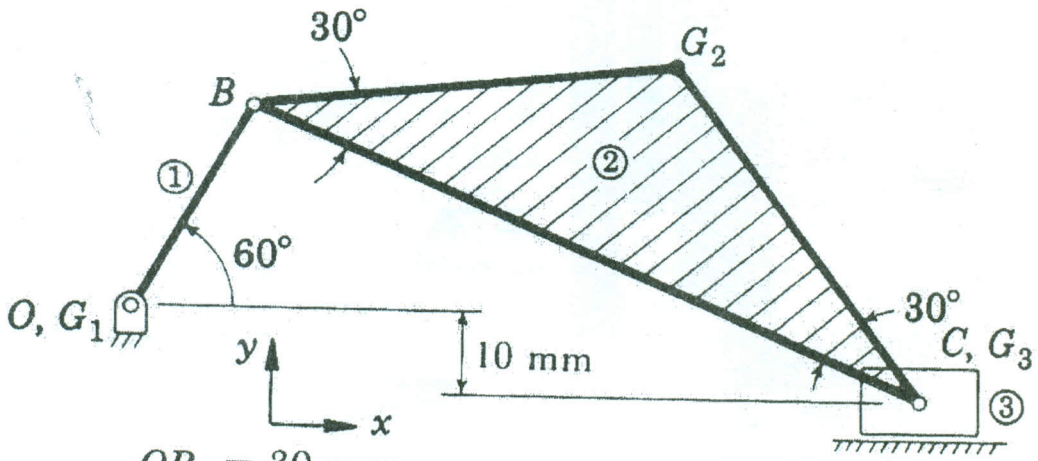
Mansoura University		Theory of Machines
Faculty of Engineering		Final-Exam Fall 2011
Prod. Eng. & Mech. Design Dept.		Time: 3 hours

(Open Notes Exams)

Please attempt the following questions:

1. The crank of the slider-crank mechanism shown below has an instantaneous angular velocity of **10 rad/s CW** and an angular acceleration of **200 rad/s^2 CW**. Acceleration information is given in the figure. The connecting rod has a mass of **15 kg** and a mass moment of inertia of **7500 kg mm^2** about its mass center G_2. The slider has a mass of **8 kg**. The crank has a moment of inertia of **4000 kg mm^2** about its stationary center of mass G_1. Determine **all bearing forces** and the input torque T_1 for the position shown.



$OB = 30$ mm

$BC = 90$ mm

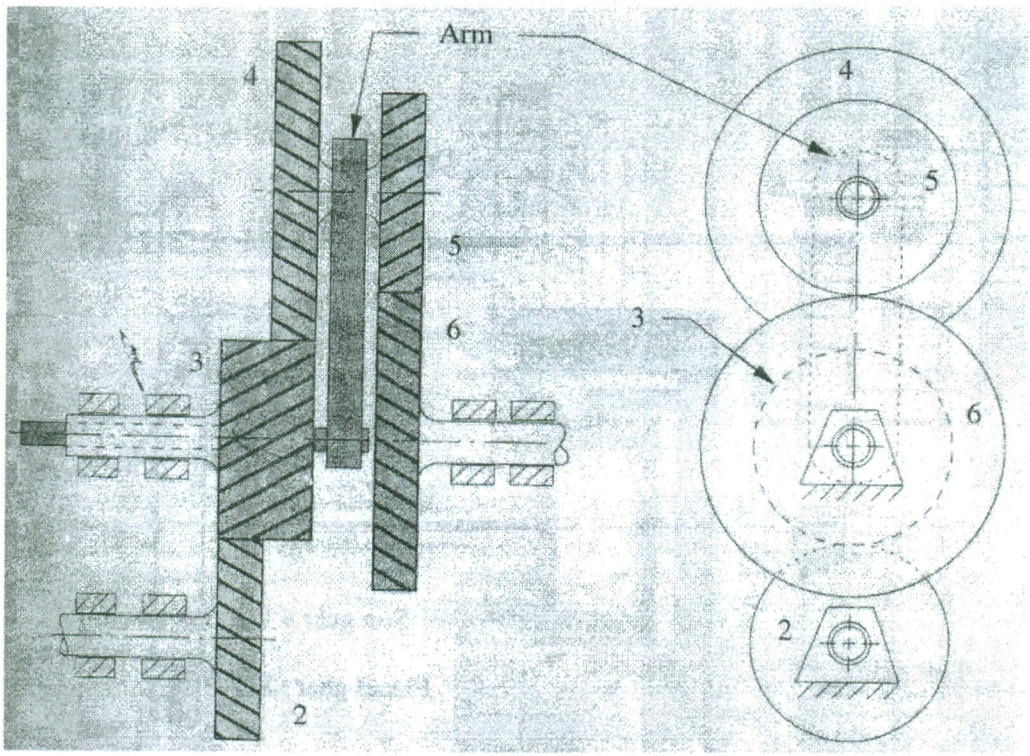
$\boldsymbol{a}_{G_2} = 3810\angle 325°$ mm/s^2

$\alpha_2 = 66.3$ rad/s^2 ccw

$\boldsymbol{a}_{G_3} = 5800\angle 0°$ mm/s^2

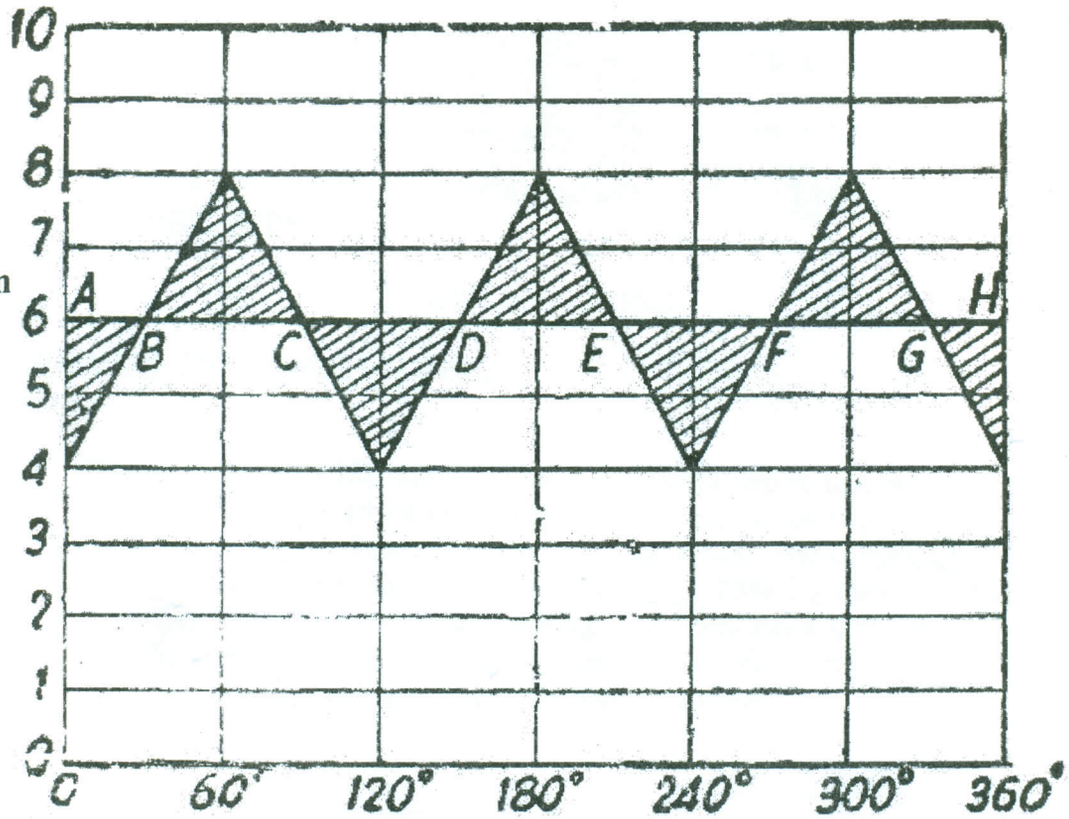
2. A cam with radial flat faced follower rotates 100 rpm clockwise. The follower motion consists of rise and fall **only**. The rise and the fall are carried out with cycloidal motion. The cam rotation angles during both rise and fall are **equal**. The amplitude of the follower translation is ***50 mm***. Take the base circle radius to be equal ***10 mm***. Determine the equations of the cam profile. Find also the coordinates of the cam profile corresponding to the maximum velocity of the follower.

3. The figure below shows a compound planetary gear train. It has the following data: $N_2 = 30$, $N_3 = 35$, $N_4 = 55$, $N_5 = 40$, $N_6 = 50$, $\omega_2 = 30$ **rpm CCW**, $\omega_{arm} =$ **90 rpm CW**. Gears 4 and 5 are **fixed together**. Find the speed of **gear 6** and the direction of its rotation.



4. The torque crank-angle diagram of a three-cylinder single-acting-engine and the mean resisting torque of **6 Nm** are shown below. The average speed is **100 rpm**. Determine:

   a) The **power** developed.
   b) The required **moment of inertia of the flywheel** to keep the coefficient of speed fluctuation within **4%**.



5. A shaft carries five masses m_1, m_2, m_3, m_4 and m_5 which revolve at the **same radius** in planes which are **equidistant one from another**. The magnitudes of the masses in planes **1**, **3** and **4** are **50 kg**, **40 kg** and **80 kg** respectively. The angular positions of masses 3 and 4 **with respect to mass 1** are **75°** and **135°** respectively. Determine the masses in planes **2** and **5** and their angular positions **with respect to mass 1** to put the shaft in complete rotating balance.