

1. Determine the  $x$ - and  $y$ -coordinates of the centroid of the shaded area in Fig. 1. (15%)

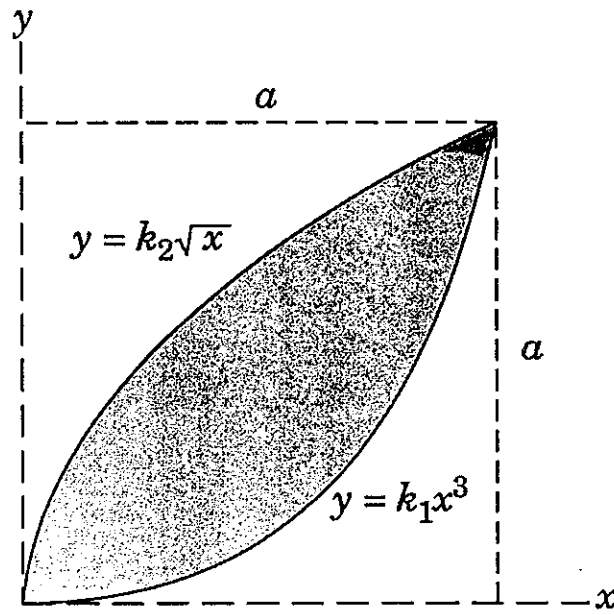


Fig. 1

2. Determine the force in member CG of the loaded truss, as shown in Fig. 2. Assume that the four external reactions at A, B, E, and F are equal in magnitude and are directed perpendicular to the local supporting surface. (15%)

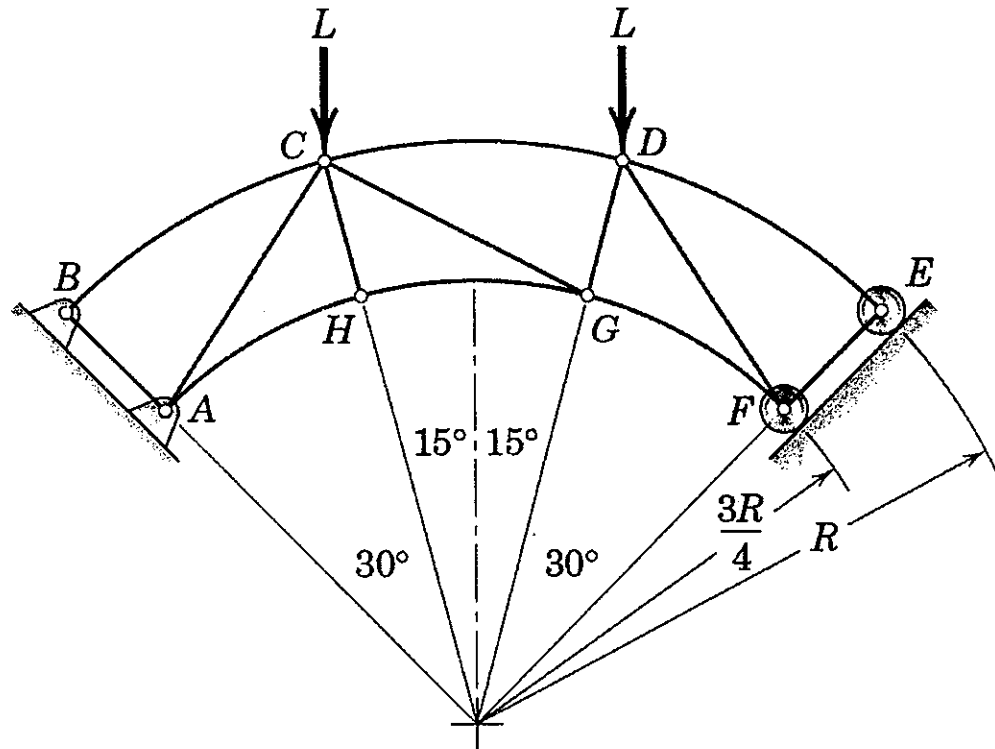


Fig. 2

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3. Two sheets  $S_1$  and  $S_2$  have the same size  $L \times W \times t$ , Young's Modulus of  $S_1$  is  $E_1=E$ , Young's Modulus of  $S_2$  is  $E_2=2E$ , different thermal expansion coefficients  $\alpha$  and  $\beta=1.2\alpha$ , as shown in Fig.3. They are firmly attached together.

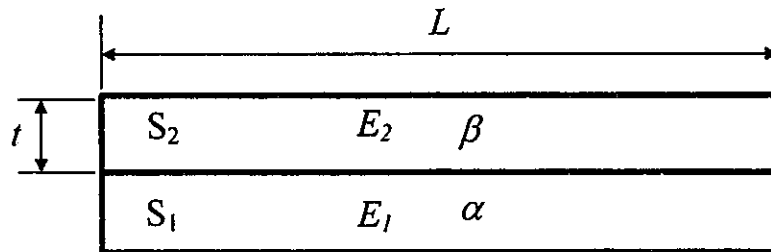


Fig.3 Bi-sheet

When the temperature rises from  $T_0$  to  $T$ , please derive the following parameters with the above-mentioned dimensional parameters ( $T_0, T, \alpha, E, L, W, t$ )

- The thermal expansion deflections  $\Delta l_{s_1}$  and  $\Delta l_{s_2}$  of the both unattached sheets. (4%)
  - According to the force equilibrium condition, how is the longitudinal forces  $F_{s_1}$  and  $F_{s_2}$  inside the attached sheets. (4%)
  - The bending moment  $M$  and its distribution along the Bi-Sheet. (6%)
  - Please draw the moment distribution and the deflected form along the Bi-sheet. (2%)
4. A block brake with the hinge location C is shown in Fig.4. The friction coefficient between lining and drum is  $\mu$ .

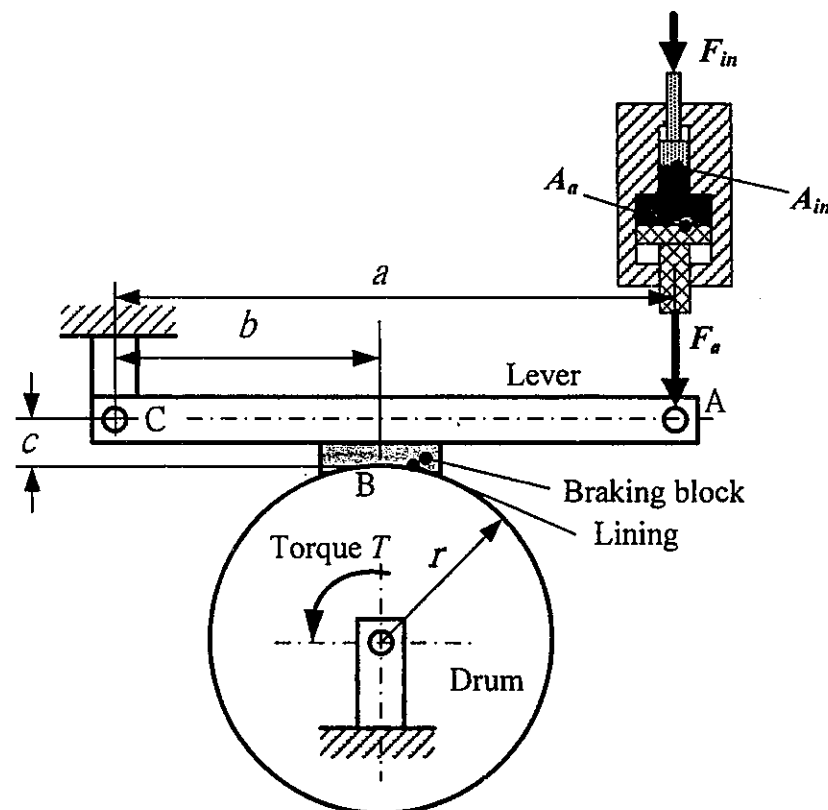


Fig.4 Block brake

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(Continue Problem 4) Please derive the following parameters with the above-mentioned dimensional parameters ( $\mu, A_{in}, A_a, a, b, c, r, N, F_{in}, F_a$ ).

- (a) The acting force  $F_a$  induced by the input force  $F_{in}$  through the hydraulic piston with different piston area  $A_{in}$  and  $A_a$ . (5%)
- (b) The free body diagram for the actuating lever with the braking block. (4%)
- (c) The normal force  $N$  between the lining and the drum. (5%)
- (d) The horizontal and vertical reaction forces,  $R_h$  and  $R_v$ , at the pin location C. (5%)
- (e) The braking torque  $T_b$  on the drum. (5%)

5. A portion of a square-threaded power screw with single thread having a mean diameter  $d_m$ , a pitch  $p$ , and a lead angle  $\lambda$  is loaded by an axial compressive force  $F$ , as shown in Fig. 5. Please (a) find an expression for the torque required to raise this load, (b) find an expression for the torque required to lower the load, and (c) find the condition for self-locking. (5%) (5%) (5%)

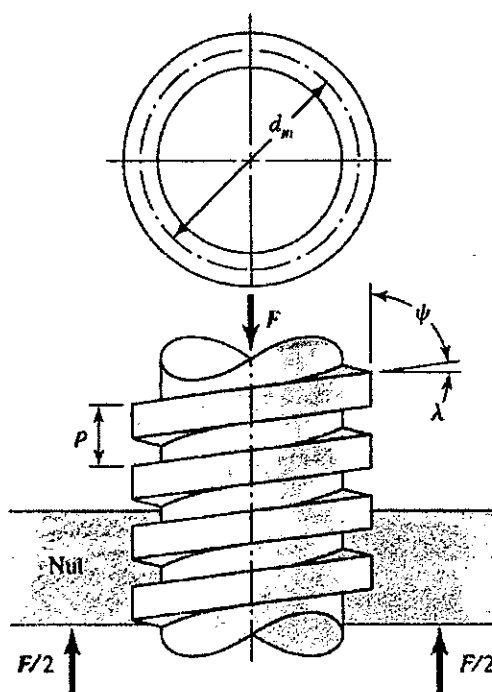


Fig. 5 A power screw

6. A couple  $M$  is applied to crank  $QR$  in order to maintain the equilibrium of the engine system when a force  $F$  is applied to the piston, as shown in Fig. 6. Please use the method of virtual work to express the relationship between  $M$  and  $F$ , using  $\Phi$ ,  $\theta$ , and  $QR$ . (15%)

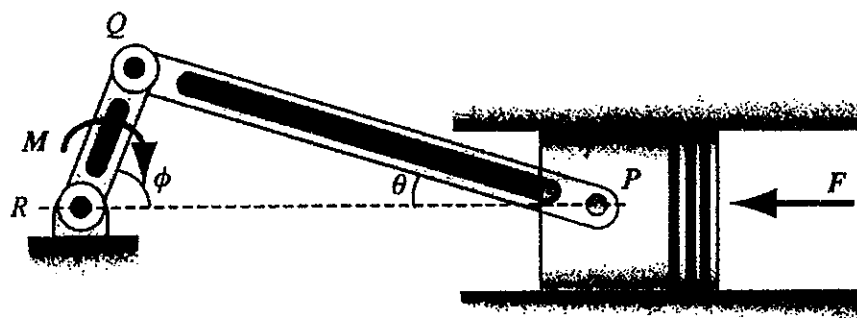


Fig. 6 An engine system

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