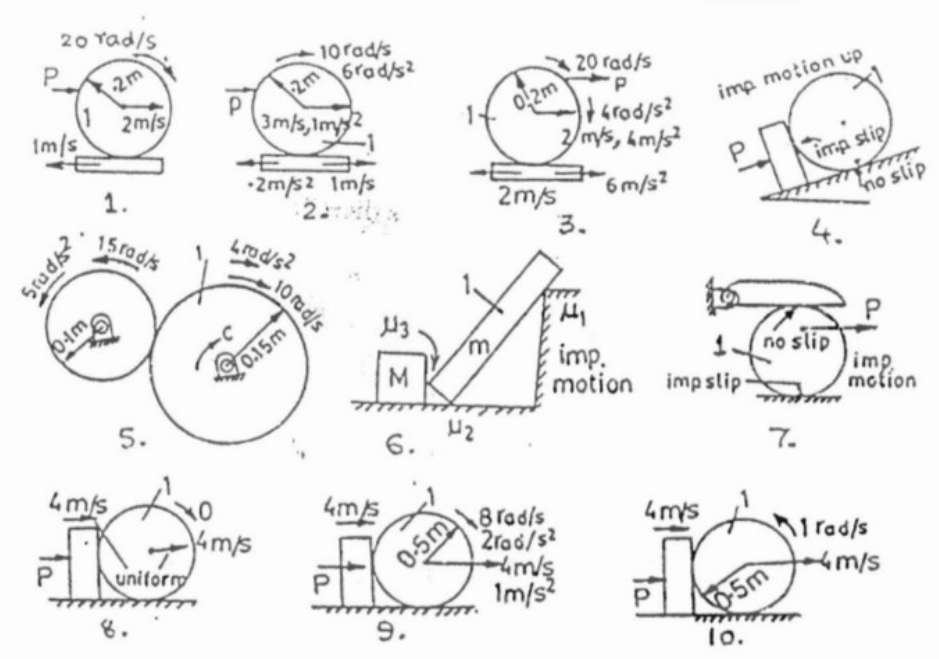
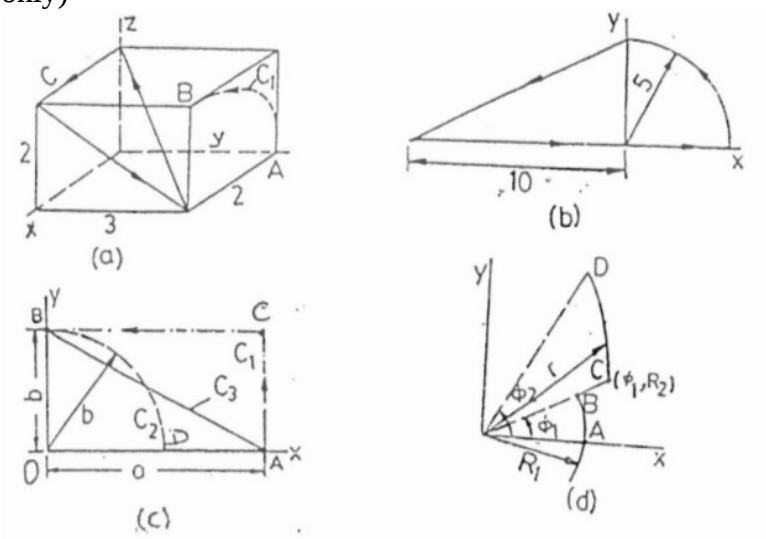
APL100
Practice problems 5

1. Draw FBD of body 1 of mass *m* for cases 1. and 2. in the figure. The coefficients of friction are μ_s, μ_k.

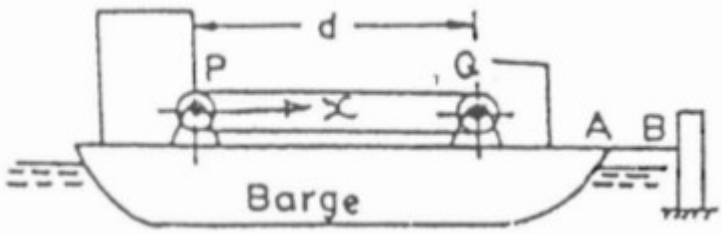


2. (a) Is the force $\underline{F} = (-2xy + yz)\,\underline{i} + (-x^2 + xz - z)\,\underline{j} + (xy - y)\,\underline{k}$ conservative? Find its potential energy if conservative. Find the work done by it in a closed path C and in an open circular path C_1 (Fig.P2.22a). (b) Is $\underline{F} = (5x^2 + xy)\,\underline{i} + (10xy + y^2)\,\underline{j}$ conservative? Find the work done by it in a closed path (Fig.P2.22b). (c) A plane force field has magnitude prx and is directed towards O. Is it conservative? Find the work done by it for the three paths shown in Fig.P2.22c followed by its point of application from point A to point B. (d) Find the work done by the force $\underline{F} = (c_1\phi^2 r + c_2)\,\underline{e}_r + (c_3\phi^2/r)\,\underline{e}_\phi$ over the path $ABCD$ shown in Fig.P2.22d, where $r = R_2 + c_4(\phi - \phi_1)$ for portion CD and c_i are constants. Is this force conservative? (e) Is the force $\underline{F} = c_1 r^2\,\underline{e}_r + c_2\,\underline{e}_\phi + c_3 z\,\underline{e}_z$ conservative? Find the work done by it when its material point of application moves over a conical helix: $\underline{r} = (r_0 - \alpha\phi)\,\underline{e}_r + \beta\phi\,\underline{e}_z$ from $\phi = 0$ to $\phi = \pi$.

(parts (a) and (d) only)



3. A barge is at rest and is tied to the ground by cable AB (Fig.Q2.30). Find the force in the cable when grain is transported by a conveyor at $m(t)$ kg/s (a) from position P to Q and (b) from position Q to P. Neglect water resistance.



4. A tugboat of mass m moving at v_0 starts towing a stationary ship of mass M (Fig.P2.36). Neglect the impulse of the propeller thrust of the tugboat and the resistance of water during the period the tow-rope is stretched to its maximum when the boat and the ship have common velocity. The tow-rope extends e m/m length for 1 kN load and its allowable load is P_0. Prove that the minimum required length L of the rope is given by $L = 1000(mv_0^2/eP_0^2)M/(M+m)$. The load in the rope can thus be reduced by using 1. a rope with greater flexibility e, 2. a long rope, 3. a helical spring in series as in ropes used by mountain climbers, 4. a friction attachment to permit the rope to slip, if its maximum tension exceeds a certain value.