Esercizi di Meccanica Applicata

Contents

Introduzione

Questo documento sarà aggiornato durante lo svolgimento del corso.

Versione 1.0, 12/10/2016 – Cap. 1 e 2;

Versione 1.1, 21/10/2016 – aggiornata soluzione esercizio 12-66;

Versione 2.0, 28/10/2016; Cap 3

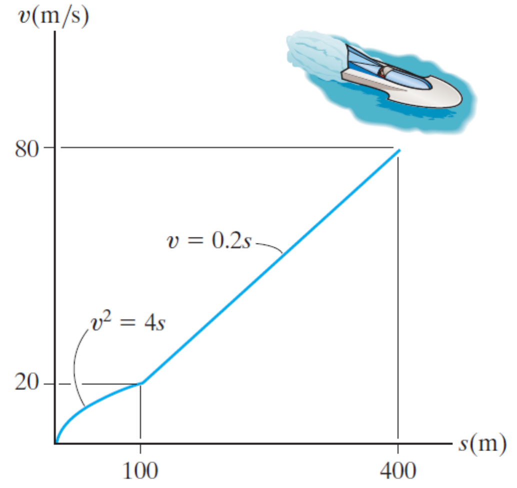
Versione 2.1, 11/11/2016; aggiunto qualche esercizio al Cap 3

Versione 3.0, 06/12/2016; Cap 4

1. Cinematica del punto

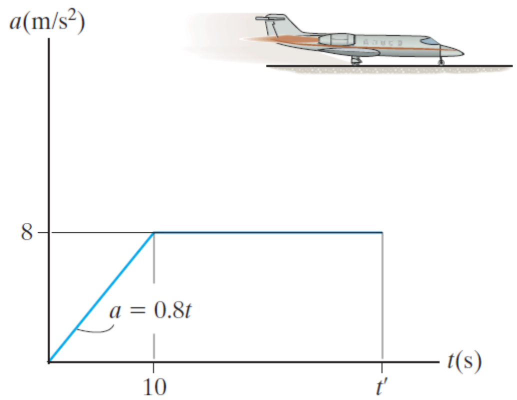
1.1. Problemi

12–66. The boat travels along a straight line with the speed described by the graph. Construct the s–t and $a-s$ graphs. Also, determine the time required for the boat to travel a distance $s = 400$ m if $s = 0$ when $t = 0$.



Prob. 12–66

•**12–69.** The airplane travels along a straight runway with an acceleration described by the graph. If it starts from rest and requires a velocity of 90 m/s to take off, determine the minimum length of runway required and the time t' for take off. Construct the $v-t$ and s–t graphs.

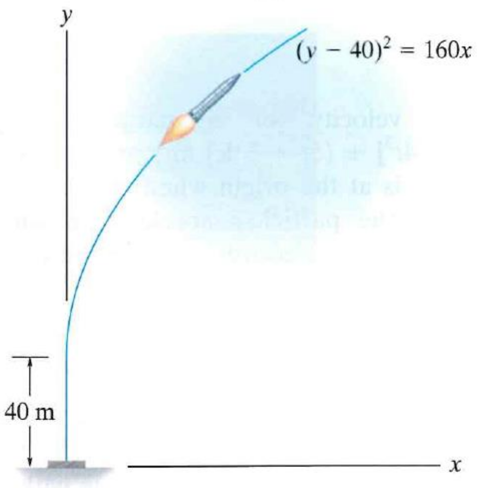


Prob. 12–69

12–74. A particle moves along the curve $y = e^{2x}$ such that its velocity has a constant magnitude of $v = 4$ m/s. Determine the x and y components of velocity when the particle is at $y = 5$ m.

12–75. The path of a particle is defined by $y^2 = 4kx$, and the component of velocity along the y axis is $v_y = ct$, where both k and c are constants. Determine the x and y components of acceleration.

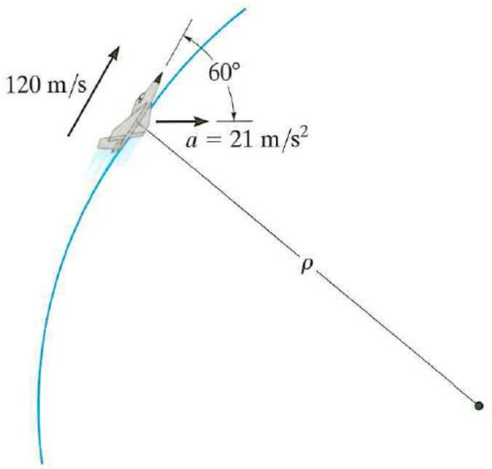
12–79. When a rocket reaches an altitude of 40 m it begins to travel along the parabolic path $(y - 40)^2 = 160x$, where the coordinates are measured in meters. If the component of velocity in the vertical direction is constant at $v_y = 180$ m/s, determine the magnitudes of the rocket's velocity and acceleration when it reaches an altitude of 80 m.



Prob. 12–79

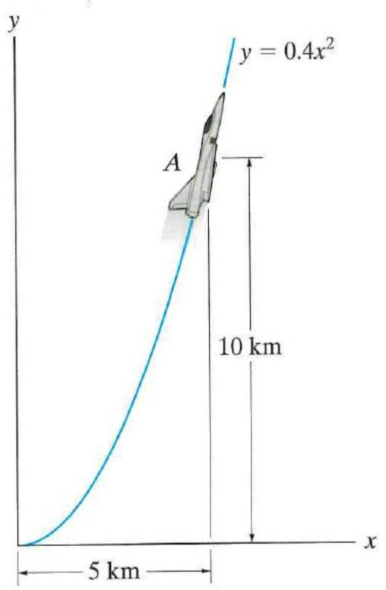
12–101. A car moves along a circular track of radius 75 m such that its speed for a short period of time, $0 \leq t \leq 4$ s, is $v = 0.9(t + t^2)$ m/s, where t is in seconds. Determine the magnitude of its acceleration when $t = 3$ s. How far has it traveled in $t = 3$ s?

12–102. At a given instant the jet plane has a speed of 120 m/s and an acceleration of 21 m/s^2 acting in the direction shown. Determine the rate of increase in the plane's speed and the radius of curvature ρ of the path.



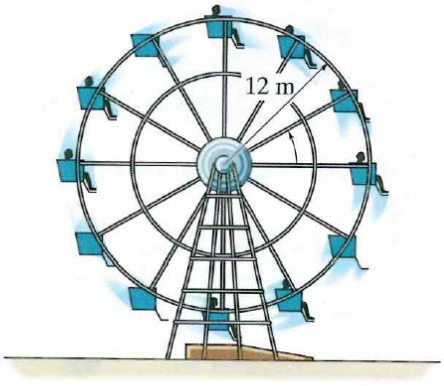
Prob. 12–102

12–106. The jet plane travels along the vertical parabolic path. When it is at point A it has a speed of 200 m/s, which is increasing at the rate of 0.8 m/s^2. Determine the magnitude of acceleration of the plane when it is at point A.



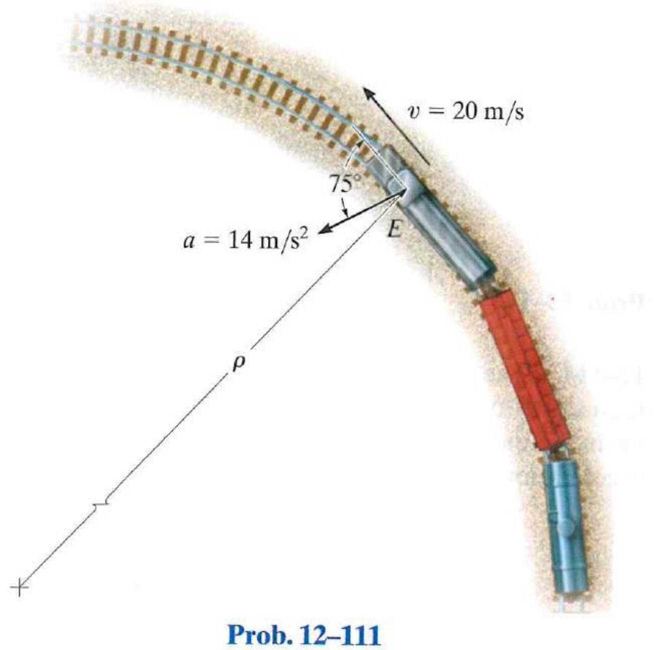
Prob. 12–106

12–110. The Ferris wheel turns such that the speed of the passengers is increased by $\dot{v} = (1.2t)\ \text{m/s}^2$, where t is in seconds. If the wheel starts from rest when $\theta = 0°$, determine the magnitudes of the velocity and acceleration of the passengers when the wheel turns $\theta = 30°$.



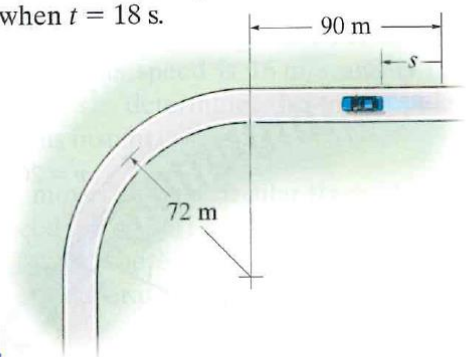
Prob. 12–110

12–111. At a given instant the train engine at E has a speed of 20 m/s and an acceleration of 14 m/s^2 acting in the direction shown. Determine the rate of increase in the train's speed and the radius of curvature ρ of the path.



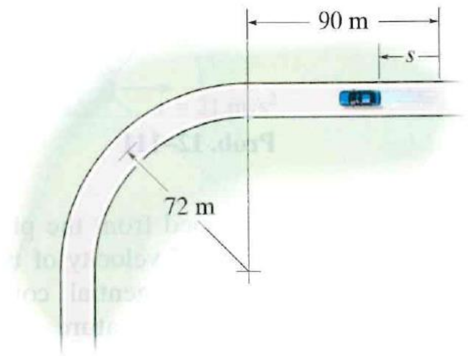
Prob. 12–111

12–113. The automobile is originally at rest at $s = 0$. If its speed is increased by $\dot{v} = (0.015t^2)\ \text{m/s}^2$, where t is in seconds, determine the magnitudes of its velocity and acceleration when $t = 18$ s.



Prob. 12–113

12–114. The automobile is originally at rest $s = 0$. If it then starts to increase its speed at $\dot{v} = (0.015t^2)\ \text{m/s}^2$, where t is in seconds, determine the magnitudes of its velocity and acceleration at $s = 165$ m.



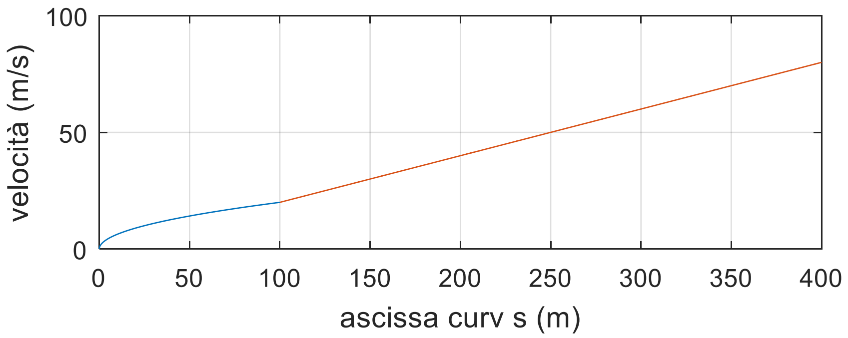
Prob. 12–114

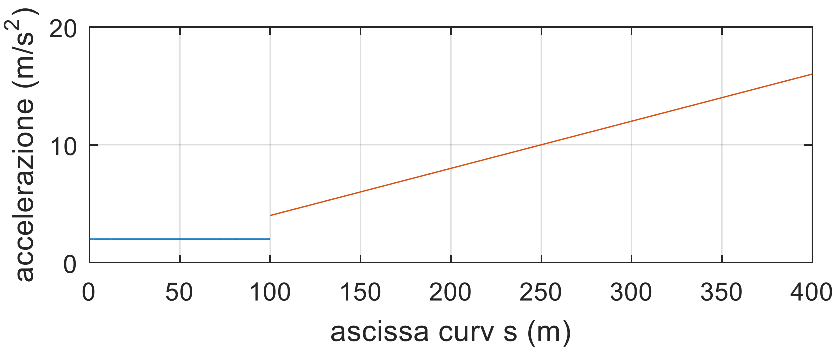
1.2. Risposte

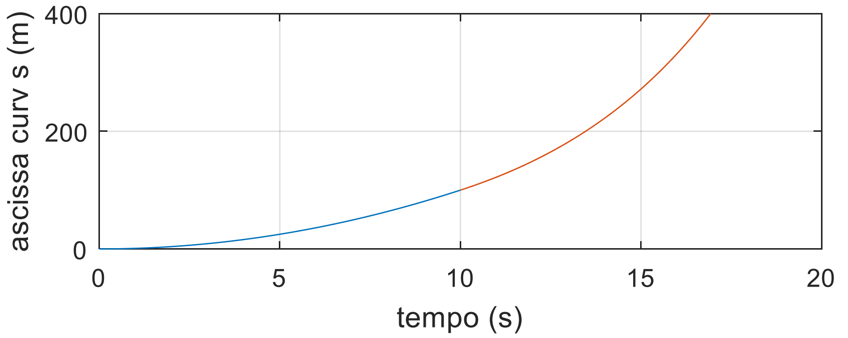
12-66. suggerimento: v=ds/dt; a= v dv/ds

tratto 1 : a=2 m/s² (costante), t(s=100m) = 10 sec

tratto 2 : a= 0.04 s (m/s²), t=10+5(log(s)-log(100) ; t(s=400 m)=16.9 sec







12–69.
$$v = \left(0.4t^2\right)\ \mathrm{m/s}$$
$$v = (8t - 40)\ \mathrm{m/s}$$
$$t' = 16.25\ \mathrm{s}$$
$$s\big|_{t=16.25\ \mathrm{s}} = 540\ \mathrm{m}$$

12–74. $v_x = 0.40\ \text{m/s}$; $v_y = 3.98\ \text{m/s}$

12–75. $a_x = \dfrac{c}{2k}(y + ct^2)$; $a_y = c$

12–77. $d = 204\ \text{m}$; $v = 41.8\ \text{m/s}$;
$a = 4.66\ \text{m/s}^2$

12–78. $v_0 = 7.96\ \text{m/s}$; $v_B = 32.3\ \text{m/s}$

12–79. $v = 201\ \text{m/s}$; $a = 405\ \text{m/s}^2$

12–101. $a = 6.49\ \text{m/s}^2$; $\Delta s = 12.1\ \text{m}$

12–102. $a_t = 10.5\ \text{m/s}^2$; $\rho = 791.8\ \text{m}$

12–103. $a_p = 180\ \text{m/s}^2$; $a_{p'} = 72\ \text{m/s}^2$;

12–105. $v = 1.96\ \text{m/s}$; $a = 0.930\ \text{m/s}^2$

12–106. $a = 0.921\ \text{m/s}^2$

12–107. $a = 4.22\ \text{m/s}^2$

12–109. $x = 0$, $y = -4\ \text{m}$; $(a)_{\text{max}} = 50\ \text{m/s}^2$

12–110. $v = 6\ \text{m/s}$; $a = 4.81\ \text{m/s}^2$

12–111. $a_t = 3.62\ \text{m/s}^2$; $\rho = 29.6\ \text{m}$

12–113. $v = 29.2\ \text{m/s}$; $a = 12.8\ \text{m/s}^2$

12–114. $v = 34.6\ \text{m/s}$; $a = 17.5\ \text{m/s}^2$

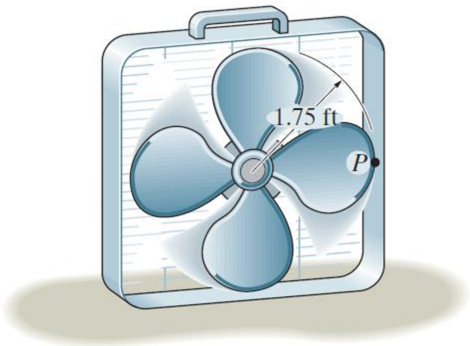
2. Cinematica dei corpi rigidi

2.1. Problemi

Nota bene, in alcuni dei seguenti problemi vengono usate le unità di misura imperiali:

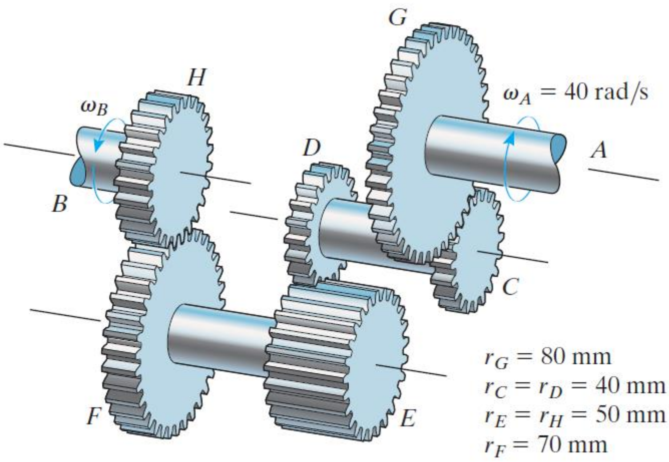
- 1 in = 0.0254 m
- 1 ft = 0.3048 m

16–2. Just after the fan is turned on, the motor gives the blade an angular acceleration $\alpha = (20e^{-0.6t})\ \text{rad/s}^2$, where t is in seconds. Determine the speed of the tip P of one of the blades when $t = 3$ s. How many revolutions has the blade turned in 3 s? When $t = 0$ the blade is at rest.



Prob. 16–2

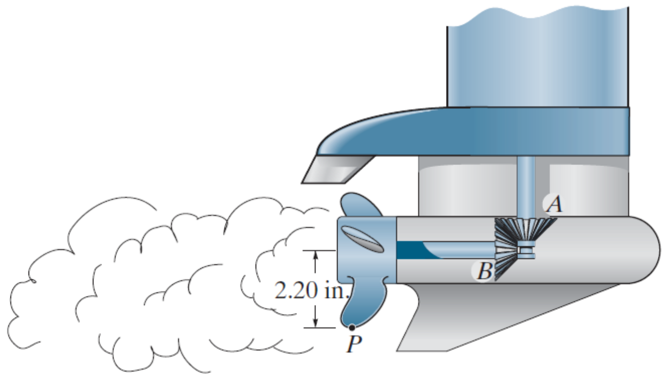
•16–5. The operation of reverse gear in an automotive transmission is shown. If the engine turns shaft A at $\omega_A = 40$ rad/s, determine the angular velocity of the drive shaft, ω_B. The radius of each gear is listed in the figure.



Prob. 16–5

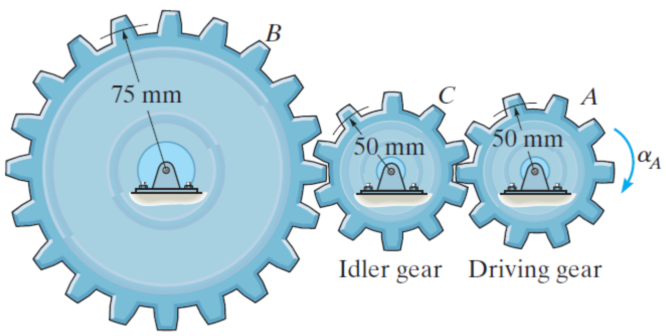
16–7. The gear A on the drive shaft of the outboard motor has a radius $r_A = 0.5$ in. and the meshed pinion gear B on the propeller shaft has a radius $r_B = 1.2$ in. Determine the angular velocity of the propeller in $t = 1.5$ s, if the drive shaft rotates with an angular acceleration $\alpha = (400t^3)$ rad/s^2, where t is in seconds. The propeller is originally at rest and the motor frame does not move.

***16–8.** For the outboard motor in Prob. 16–7, determine the magnitude of the velocity and acceleration of point P located on the tip of the propeller at the instant $t = 0.75$ s.



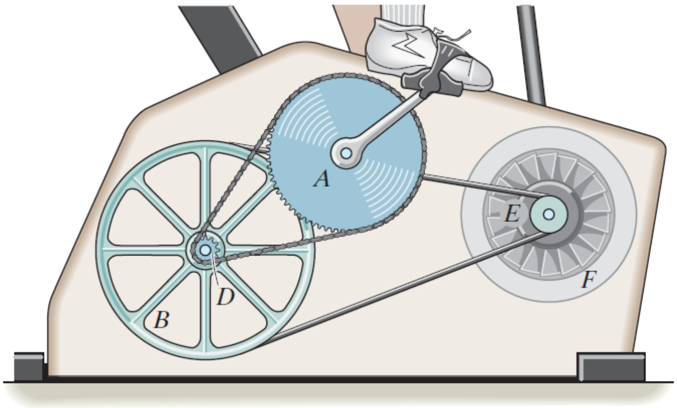
Probs. 16–7/8

•16–9. When only two gears are in mesh, the driving gear A and the driven gear B will always turn in opposite directions. In order to get them to turn in the *same direction* an idler gear C is used. In the case shown, determine the angular velocity of gear B when $t = 5$ s, if gear A starts from rest and has an angular acceleration of $\alpha_A = (3t + 2)$ rad/s^2, where t is in seconds.



16–30. If the operator initially drives the pedals at 20 rev/min, and then begins an angular acceleration of 30 rev/min^2, determine the angular velocity of the flywheel F when $t = 3$ s. Note that the pedal arm is fixed connected to the chain wheel A, which in turn drives the sheave B using the fixed connected clutch gear D. The belt wraps around the sheave then drives the pulley E and fixed-connected flywheel.

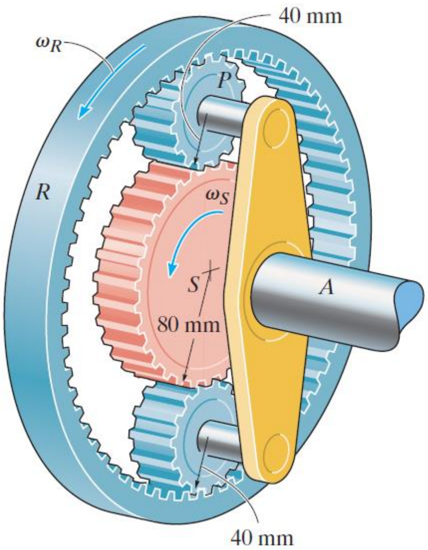
16–31. If the operator initially drives the pedals at 12 rev/min, and then begins an angular acceleration of 8 rev/min^2, determine the angular velocity of the flywheel F after the pedal arm has rotated 2 revolutions. Note that the pedal arm is fixed connected to the chain wheel A, which in turn drives the sheave B using the fixed-connected clutch gear D. The belt wraps around the sheave then drives the pulley E and fixed-connected flywheel.



$r_A = 125$ mm $\quad r_B = 175$ mm
$r_D = 20$ mm $\quad r_E = 30$ mm

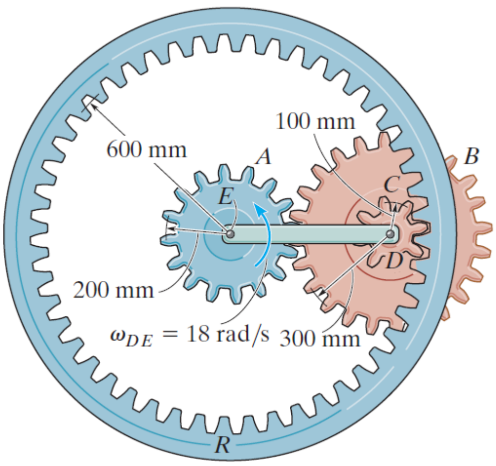
Probs. 16–30/31

*16–64. The planetary gear system is used in an automatic transmission for an automobile. By locking or releasing certain gears, it has the advantage of operating the car at different speeds. Consider the case where the ring gear R is held fixed, $\omega_R = 0$, and the sun gear S is rotating at $\omega_S = 5$ rad/s. Determine the angular velocity of each of the planet gears P and shaft A.



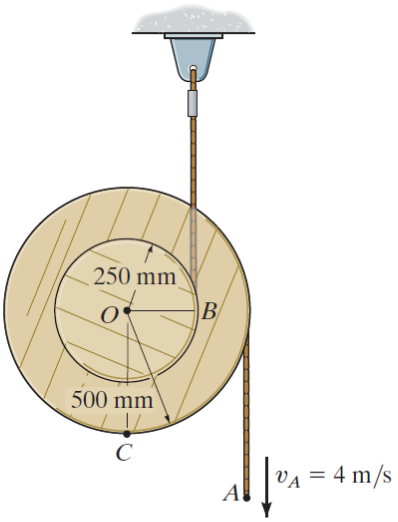
Prob. 16–64

*16–72. The epicyclic gear train consists of the sun gear A which is in mesh with the planet gear B. This gear has an inner hub C which is fixed to B and in mesh with the fixed ring gear R. If the connecting link DE pinned to B and C is rotating at $\omega_{DE} = 18$ rad/s about the pin at E, determine the angular velocities of the planet and sun gears.



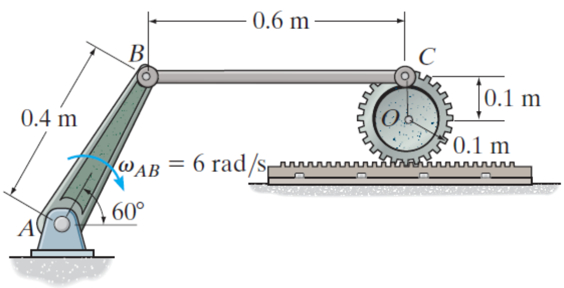
Prob. 16–72

*16–92. If end A of the cord is pulled down with a velocity of $v_A = 4$ m/s, determine the angular velocity of the spool and the velocity of point C located on the outer rim of the spool.



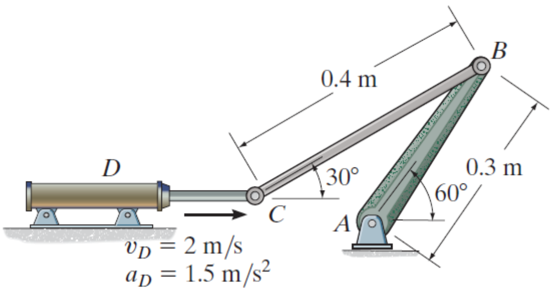
Prob. 16–92

•**16–105.** If crank AB is rotating with an angular velocity of $\omega_{AB} = 6$ rad/s, determine the velocity of the center O of the gear at the instant shown.



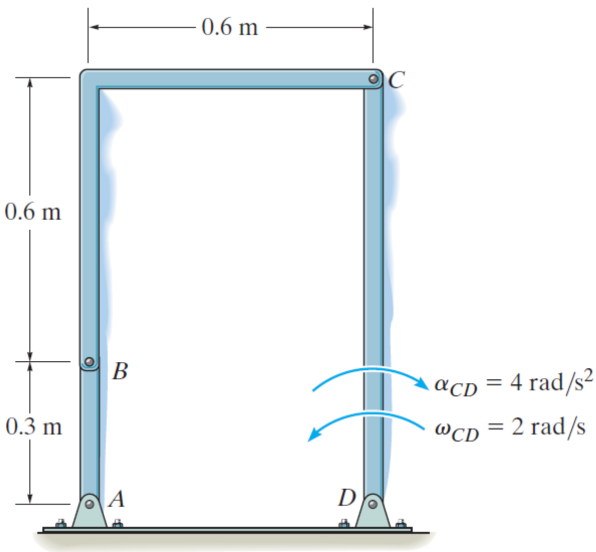
Prob. 16–105

•16–125. The hydraulic cylinder is extending with the velocity and acceleration shown. Determine the angular acceleration of crank AB and link BC at the instant shown.



Prob. 16–125

•16–129. Determine the angular acceleration of link AB if link CD has the angular velocity and angular deceleration shown.



2.2. Risposte

16–2. $v_P = 48.7$ ft/s
$\theta = 8.54$ rev

16–3. $a_t = \alpha r; \qquad 20 = \alpha(2)$
$\omega = 35.4$ rad/s
$\theta = 35.3$ rev

16–5. $\omega_C = \omega_D = 80$ rad/s
$\omega_E = \omega_F = 64$ rad/s
$\omega_B = 89.6$ rad/s

16–7. $\omega_B = 211$ rad/s

16–9. $\omega_C = 47.5$ rad/s
$\omega_B = 31.7$ rad/s

16–30. $\omega_F = 784$ rev/min

16–31. $\omega_F = 484$ rev/min

16–105. $r_{B/IC} = 1.2$ m
$r_{C/IC} = 1.039$ m
$\omega_{BC} = 2$ rad/s
$v_O = 1.04$ m/s $\rightarrow$

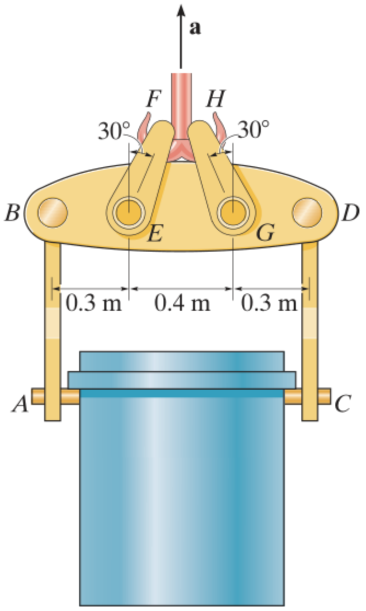
16–125. $r_{C/IC} = 0.4$ m
$r_{B/IC} = 0.6928$ m
$\omega_{BC} = 5$ rad/s
$\omega_{AB} = 11.55$ rad/s
$\alpha_{BC} = 160$ rad/s^2
$\alpha_{AB} = 173$ rad/s^2

16–129. $\omega_{BC} = 0$
$v_B = v_C = 1.8$ m/s
$(a_C)_n = 3.6$ m/s^2 $\downarrow$
$(a_C)_t = 3.6$ m/s^2 $\rightarrow$
$\alpha_{BC} = 12$ rad/s^2
$(a_B)_t = 10.8$ m/s^2
$\alpha_{AB} = 36$ rad/s^2 $\circlearrowright$

3. Dinamica dei corpi rigidi

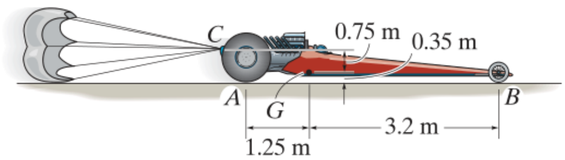
3.1. Problemi

•17–25. The 4-Mg uniform canister contains nuclear waste material encased in concrete. If the mass of the spreader beam BD is 50 kg, determine the largest vertical acceleration **a** of the system so that each of the links AB and CD are not subjected to a force greater than 30 kN and links EF and GH are not subjected to a force greater than 34 kN.



Probs. 17–24/25

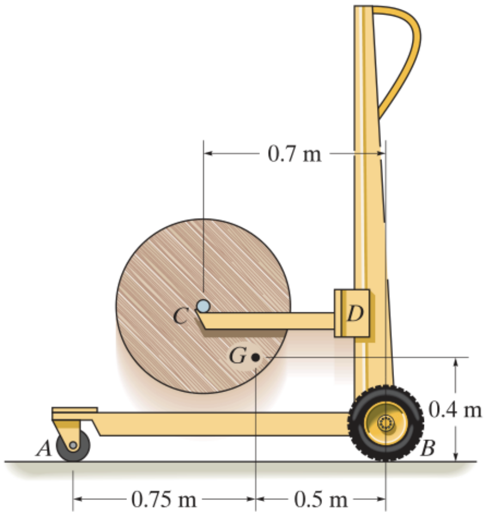
17–26. The dragster has a mass of 1200 kg and a center of mass at G. If a braking parachute is attached at C and provides a horizontal braking force of $F = (1.6v^2)$ N, where v is in meters per second, determine the critical speed the dragster can have upon releasing the parachute, such that the wheels at B are on the verge of leaving the ground; i.e., the normal reaction at B is zero. If such a condition occurs, determine the dragster's initial deceleration. Neglect the mass of the wheels and assume the engine is disengaged so that the wheels are free to roll.



Prob. 17–26

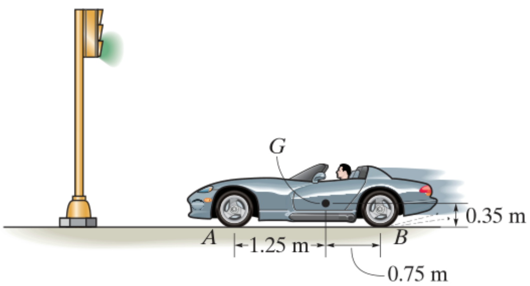
•**17–29.** The lift truck has a mass of 70 kg and mass center at G. If it lifts the 120-kg spool with an acceleration of 3 m/s^2, determine the reactions on each of the four wheels. The loading is symmetric. Neglect the mass of the movable arm CD.

17–30. The lift truck has a mass of 70 kg and mass center at G. Determine the largest upward acceleration of the 120-kg spool so that no reaction on the wheels exceeds 600 N.



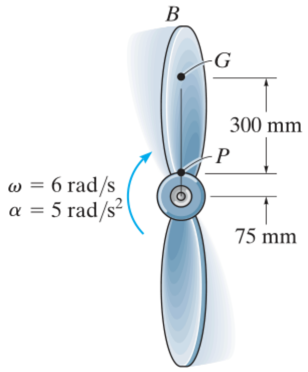
Probs. 17–29/30

17–35. The sports car has a mass of 1.5 Mg and a center of mass at G. Determine the shortest time it takes for it to reach a speed of 80 km/h, starting from rest, if the engine only drives the rear wheels, whereas the front wheels are free rolling. The coefficient of static friction between the wheels and the road is $\mu_s = 0.2$. Neglect the mass of the wheels for the calculation. If driving power could be supplied to all four wheels, what would be the shortest time for the car to reach a speed of 80 km/h?



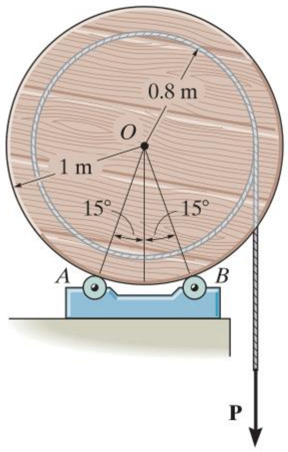
Prob. 17–35

17–58. The single blade PB of the fan has a mass of 2 kg and a moment of inertia $I_G = 0.18 \text{ kg} \cdot \text{m}^2$ about an axis passing through its center of mass G. If the blade is subjected to an angular acceleration $\alpha = 5 \text{ rad/s}^2$, and has an angular velocity $\omega = 6 \text{ rad/s}$ when it is in the vertical position shown, determine the internal normal force N, shear force V, and bending moment M, which the hub exerts on the blade at point P.



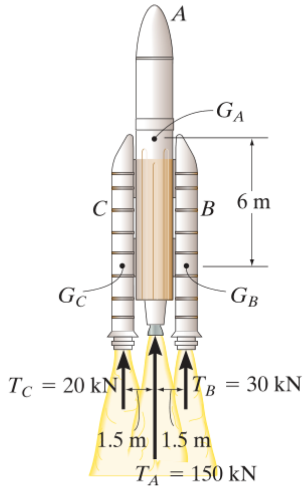
Prob. 17–58

17–59. The uniform spool is supported on small rollers at A and B. Determine the constant force **P** that must be applied to the cable in order to unwind 8 m of cable in 4 s starting from rest. Also calculate the normal forces on the spool at A and B during this time. The spool has a mass of 60 kg and a radius of gyration about O of $k_O = 0.65$ m. For the calculation neglect the mass of the cable and the mass of the rollers at A and B.



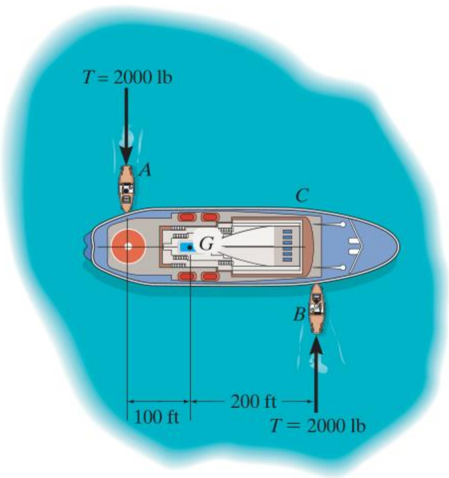
Prob. 17–59

17–95. The rocket consists of the main section A having a mass of 10 Mg and a center of mass at G_A. The two identical booster rockets B and C each have a mass of 2 Mg with centers of mass at G_B and G_C, respectively. At the instant shown, the rocket is traveling vertically and is at an altitude where the acceleration due to gravity is $g = 8.75\ \text{m/s}^2$. If the booster rockets B and C suddenly supply a thrust of $T_B = 30\ \text{kN}$ and $T_C = 20\ \text{kN}$, respectively, determine the angular acceleration of the rocket. The radius of gyration of A about G_A is $k_A = 2\ \text{m}$ and the radii of gyration of B and C about G_B and G_C are $k_B = k_C = 0.75\ \text{m}$.



Prob. 17–95

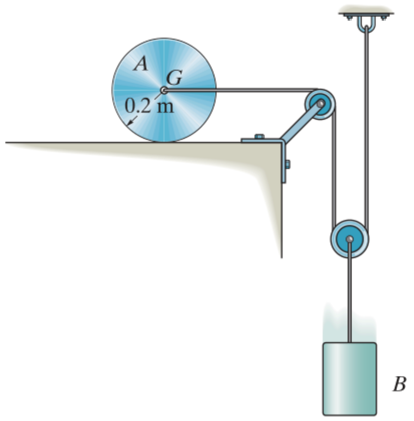
17–110. The ship has a weight of $4(10^6)$ lb and center of gravity at G. Two tugboats of negligible weight are used to turn it. If each tugboat pushes on it with a force of $T = 2000$ lb, determine the initial acceleration of its center of gravity G and its angular acceleration. Its radius of gyration about its center of gravity is $k_G = 125$ ft. Neglect water resistance.



Prob. 17–110

17–114. The 20-kg disk A is attached to the 10-kg block B using the cable and pulley system shown. If the disk rolls without slipping, determine its angular acceleration and the acceleration of the block when they are released. Also, what is the tension in the cable? Neglect the mass of the pulleys.

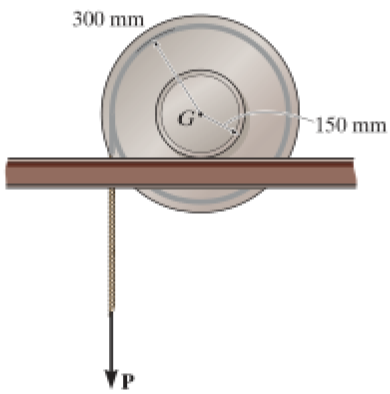
17–115. Determine the minimum coefficient of static friction between the disk and the surface in Prob. 17–114 so that the disk will roll without slipping. Neglect the mass of the pulleys.



Probs. 17–114/115

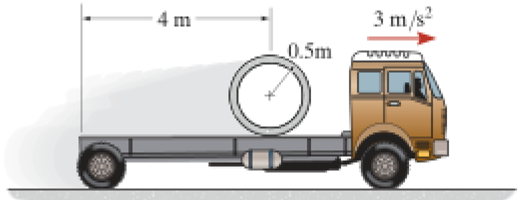
17–118. The spool has a mass of 100 kg and a radius of gyration of $k_G = 200$ mm about its center of mass G. If a vertical force of $P = 200$ N is applied to the cable, determine the acceleration of G and the angular acceleration of the spool. The coefficients of static and kinetic friction between the rail and the spool are $\mu_s = 0.3$ and $\mu_k = 0.25$, respectively.

17–119. The spool has a mass of 100 kg and a radius of gyration of $k_G = 200$ mm about its center of mass G. If a vertical force of $P = 500$ N is applied to the cable, determine the acceleration of G and the angular acceleration of the spool. The coefficients of static and kinetic friction between the rail and the spool are $\mu_s = 0.2$ and $\mu_k = 0.15$, respectively.



Probs. 17–118/119

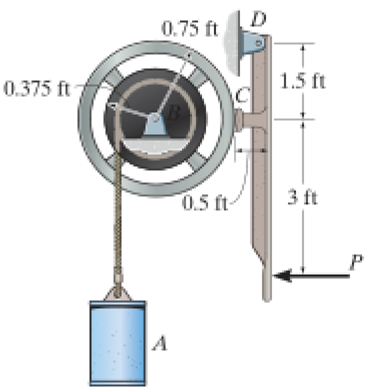
17–123. The 500-kg concrete culvert has a mean radius of 0.5 m. If the truck has an acceleration of $3\,\mathrm{m/s^2}$, determine the culvert's angular acceleration. Assume that the culvert does not slip on the truck bed, and neglect its thickness.



Prob. 17–123

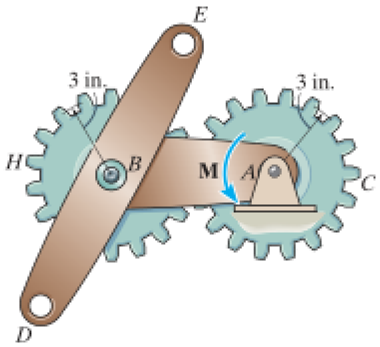
***18–28.** The 50-lb cylinder A is descending with a speed of 20 ft/s when the brake is applied. If wheel B must be brought to a stop after it has rotated 5 revolutions, determine the constant force **P** that must be applied to the brake arm. The coefficient of kinetic friction between the brake pad C and the wheel is $\mu_k = 0.5$. The wheel's weight is 25 lb, and the radius of gyration about its center of mass is $k = 0.6$ ft.

•**18–29.** When a force of $P = 30$ lb is applied to the brake arm, the 50-lb cylinder A is descending with a speed of 20 ft/s. Determine the number of revolutions wheel B will rotate before it is brought to a stop. The coefficient of kinetic friction between the brake pad C and the wheel is $\mu_k = 0.5$. The wheel's weight is 25 lb, and the radius of gyration about its center of mass is $k = 0.6$ ft.



Probs. 18–28/29

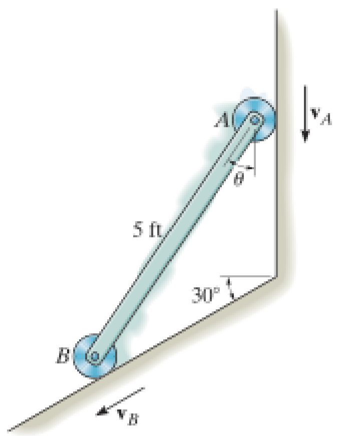
R2–15. Gears H and C each have a weight of 0.4 lb and a radius of gyration about their mass center of $(k_H)_B = (k_C)_A = 2$ in. Link AB has a weight of 0.2 lb and a radius of gyration of $(k_{AB})_A = 3$ in., whereas link DE has a weight of 0.15 lb and a radius of gyration of $(k_{DE})_B = 4.5$ in. If a couple moment of $M = 3 \text{ lb} \cdot \text{ft}$ is applied to link AB and the assembly is originally at rest, determine the angular velocity of link DE when link AB has rotated 360°. Gear C is prevented from rotating, and motion occurs in the horizontal plane. Also, gear H and link DE rotate together about the same axle at B.



Prob. R2–15

R2–35. The bar is confined to move along the vertical and inclined planes. If the velocity of the roller at A is $v_A = 6$ ft/s when $\theta = 45°$, determine the bar's angular velocity and the velocity of B at this instant.

***R2–36.** The bar is confined to move along the vertical and inclined planes. If the roller at A has a constant velocity of $v_A = 6$ ft/s, determine the bar's angular acceleration and the acceleration of B when $\theta = 45°$.



Probs. R2–35/36

3.2. Risposte

17–25. Canister : $a = 5.19\ \text{m/s}^2$
System : $a = 4.73\ \text{m/s}^2$
$a_{max} = 4.73\ \text{m/s}^2$
17–26. $a_G = 16.35\ \text{m/s}^2 \qquad v = 111\ \text{m/s}$
17–27. acceleration $F_{AB} = F_{CD} = 231\ \text{lb}$
constant speed $F_{AB} = F_{CD} = 200\ \text{lb}$
17–29. $70(9.81)(0.5) + 120(9.81)(0.7) - 2N_A(1.25)$
$= -120(3)(0.7)$
$N_A = 568\ \text{N}$
$N_B = 544\ \text{N}$
17–30. $a = 3.96\ \text{m/s}^2$

17–35. rear wheel drive $t = 17.5\ \text{s}$
All wheel drive $t = 11.3\ \text{s}$

17–58. $M_P = 2.025\ \text{N}\cdot\text{m}$
$N_P = 7.38\ \text{N}$
$V_P = 3.75\ \text{N}$
17–59. $P = 39.6\ \text{N}$
$N_A = N_B = 325\ \text{N}$

17–95. $a = 5.54\ \text{m/s}^2 \uparrow$
$\alpha = 0.293\ \text{rad/s}^2$

17–110. $a = 0$
$\alpha = 0.309(10^{-3})\ \text{rad/s}^2$

17–114. $a_B = 0.755\ \text{m/s}^2 \downarrow$
$\alpha = 7.55\ \text{rad/s}^2 \circlearrowright$
$T = 45.3\ \text{N}$
17–115. $\mu_{min} = 0.0769$

17–118. $\alpha = 9.60\ \text{rad/s}^2$
$a_G = 1.44\ \text{m/s}^2 \leftarrow$
17–119. $a_G = 2.22\ \text{m/s}^2 \leftarrow$
$\alpha = 29.2\ \text{rad/s}^2$
17–121. $\alpha = 3.89\ \text{rad/s}^2$
$a_G = 1.749\ \text{m/s}^2$
$N = 735.75\ \text{N}$
$F_f = 131.15\ \text{N}$
17–122. $\alpha = 9.51\ \text{rad/s}^2$
17–123. $a_G = 1.5\ \text{m/s}^2 \rightarrow$
$\alpha = 3\ \text{rad/s}^2$

18–29. $T_1 = 708.07\ \text{ft}\cdot\text{lb}$
$U_{W_A} = 18.75\theta$
$U_{F_f} = -40.5\theta$
$\theta = 5.18\ \text{rev}$

R2–35. $\omega = 1.08\ \text{rad/s}$
$v_B = 4.39\ \text{ft/s}$

R2–15. $\omega_{DE} = 132\ \text{rad/s}$

4. Vibrazioni 1 gdl

4.1. Problemi

2.2 A spring-mass system has a natural period of 0.21 sec. What will be the new period if the spring constant is (a) increased by 50 percent and (b) decreased by 50 percent?

2.4 A helical spring, when fixed at one end and loaded at the other, requires a force of 100 N to produce an elongation of 10 mm. The ends of the spring are now rigidly fixed, one end vertically above the other, and a mass of 10 kg is attached at the middle point of its length. Determine the time taken to complete one vibration cycle when the mass is set vibrating in the vertical direction.

2.6 The maximum velocity attained by the mass of a simple harmonic oscillator is 10 cm/s, and the period of oscillation is 2 s. If the mass is released with an initial displacement of 2 cm, find (a) the amplitude, (b) the initial velocity, (c) the maximum acceleration, and (d) the phase angle.

2.8 An automobile having a mass of 2,000 kg deflects its suspension springs 0.02 m under static conditions. Determine the natural frequency of the automobile in the vertical direction by assuming damping to be negligible.

2.13 Find the natural frequency of the pulley system shown in Fig. 2.56 by neglecting the friction and the masses of the pulleys.

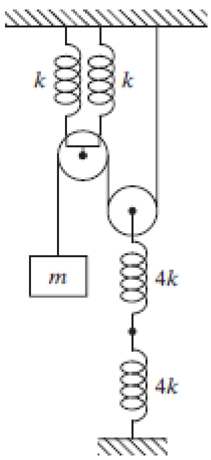


FIGURE 2.56

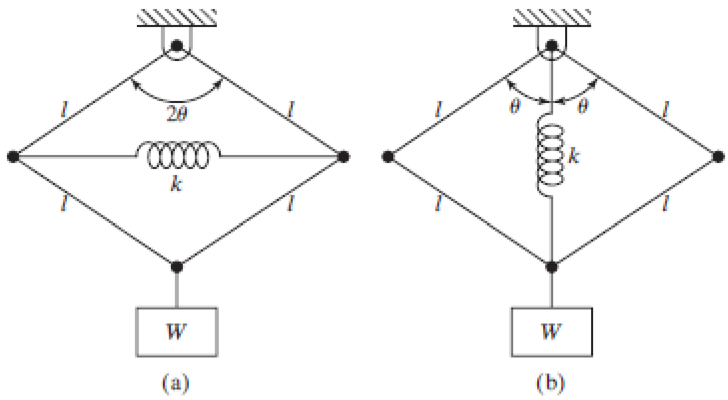


FIGURE 2.62

2.19 The natural frequency of a spring-mass system is found to be 2 Hz. When an additional mass of 1 kg is added to the original mass *m,* the natural frequency is reduced to 1 Hz. Find the spring constant *k* and the mass *m.*

2.21 Four weightless rigid links and a spring are arranged to support a weight *W* in two different ways, as shown in Fig. 2.62. Determine the natural frequencies of vibration of the two arrangements.

2.47 2.48 Derive the equation of motion using the principle of conservation of energy for each of the systems shown in Figs. 2.85 and 2.86.

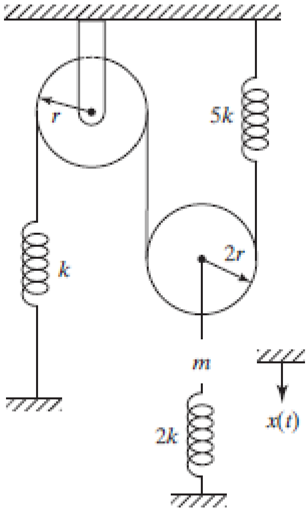


FIGURE 2.86

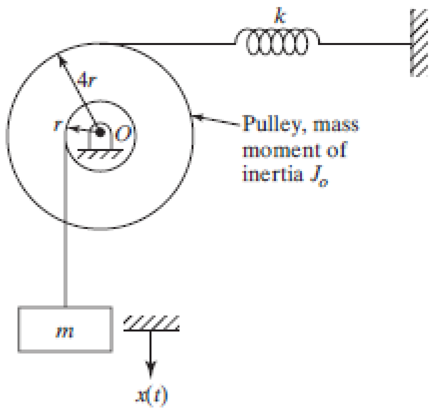


FIGURE 2.85

2.76 Find the equation of motion of the uniform rigid bar *OA* of length *l* and mass *m* shown in Fig. 2.98. Also find its natural frequency.

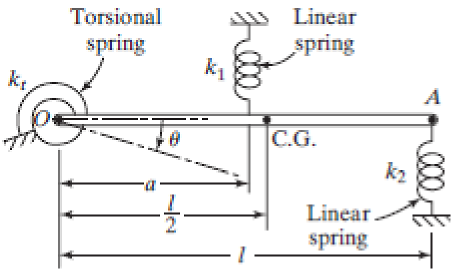


FIGURE 2.98

2.119 The system shown in Fig. 2.113 has a natural frequency of 5 Hz for the following data: m = 10 kg, J_0 = 5 kg-m^2, r_1= 10 cm, r_2= 25 cm. When the system is disturbed by giving it an initial displacement, the amplitude of free vibration is reduced by 80 percent in 10 cycles. Determine the values of *k* and *c.*

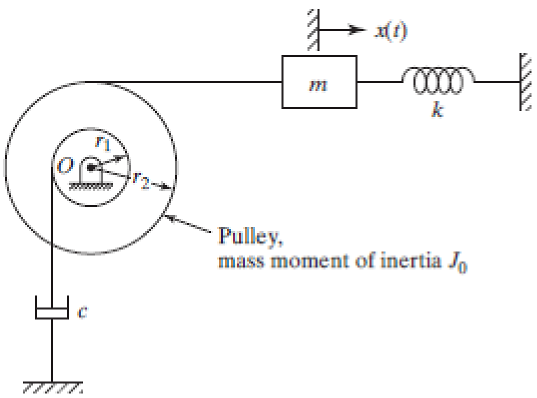


FIGURE 2.113

3.47 An air compressor of mass 100 kg is mounted on an elastic foundation. It has been observed that, when a harmonic force of amplitude 100 N is applied to the compressor, the maximum steady-state displacement of 5 mm occurred at a frequency of 300 rpm. Determine the equivalent stiffness and damping constant of the foundation.

3.48 Find the steady-state response of the system shown in Fig. 3.55 for the following data: $k_1 = 1000$ N/m, $k_2 = 500$ N/m, $c = 500$ N-s/m, $m = 10$ kg, $r = 5$ cm, $J_0 = 1$ kg-m^2, $F_0 = 50$ N, $\omega = 20$ rad/s.

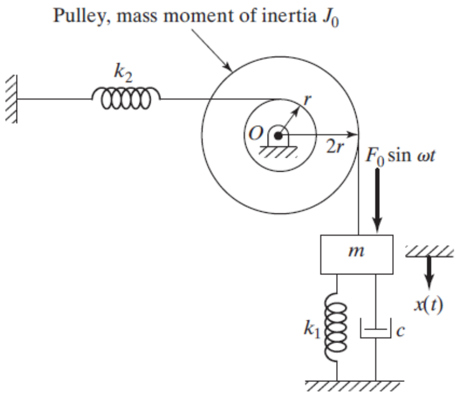


FIGURE 3.55

4.2. Risposte

Chapter 2

2.2 **(a)** 0.1715 sec, **(b)** 0.2970 sec **2.4** 0.0993 sec

2.6 **(a)** $A = 0.03183$ m, **(c)** $\ddot{x}_{max} = 0.31415$ m/s^2,
(b) $\dot{x}_0 = 0.07779$ m/s, **(d)** $\phi_0 = 51.0724°$

2.8 $\omega_n = 22.1472$ rad/sec **2.10** $\omega_n = 4.8148$ rad/sec **2.13** $\omega_n = [k/(4m)]^{1/2}$

2.15 **(a)** $\omega_n = \sqrt{\frac{4k}{M}}$, **(b)** $\omega_n = \sqrt{\frac{4k}{m+M}}$ **2.17** $\omega_n = \sqrt{\frac{g}{W}\left(\frac{3E_1I_1}{l_1^3} + \frac{48E_2I_2}{l_2^3}\right)}$

2.19 $k = 52.6381$ N/m, $m = 1/3$ kg **2.21** **(a)** $\omega_n = \sqrt{\frac{kg \operatorname{cosec}^2\theta}{W}}$, **(b)** $\omega_n = \sqrt{\frac{kg}{W}}$

2.23 **(a)** $\omega_n = \sqrt{\frac{k}{2m}}$, **(b)** $\omega_n = \sqrt{\frac{8m}{b^2}\left[l^2 - \frac{b^2}{4}\right]}$ **2.26** **(a)** $m\ddot{x} + \left(\frac{1}{a} + \frac{1}{b}\right)Tx = 0$, **(b)** $\omega_n = \sqrt{\frac{T(a+b)}{mab}}$

2.28 $T = 1656.3147$ lb **2.30** **(a)** $N = 81.914$ rpm, **(b)** $\omega_n = 37.5851$ rad/sec **2.32** $\omega_n = \sqrt{\frac{2g}{L}}$

2.34 $A = 0.9536 \times 10^{-4}$ m^2 **2.37** Torsion about z-axis **2.39** $\omega_n = 2578.9157$ rad/sec

2.42 $\mu = \sqrt{\left(\frac{\omega^2 Wc - 2kgc}{Wg + Wa\omega^2 - 2kga}\right)}$ **2.44** $m\ddot{x} + (k_1 + k_2)\,x = 0$ **2.47** $\left(m + \frac{J_0}{r^2}\right)\ddot{x} + 16kx = 0$

2.49 $\omega_n = 359.6872$ rad/sec **2.51** $x(t) = 0.1 \cos 15.8114t + 0.3162 \sin 15.8114t$ m

2.53 $x_0 = 0.007864$ m; $\dot{x}_0 = -0.013933$ m/s **2.55** $\dot{x}_0 = 4$ m/s **2.57** $d = 0.1291$ in, $N = 29.58$

2.64 $\omega_n = 2$ rad/s, $l = 2.4525$ m **2.66** $\tau_n = 1.4185$ sec **2.68** $\omega_n = 13.4841$ rad/sec

2.70 $\tau_n = 0.04693$ sec **2.72** $\omega_n = 17.7902$ rad/sec **2.74** $\omega_n = \left\{\frac{(k_1 + k_2)(R + a)^2}{1.5mR^2}\right\}^{1/2}$

2.76 $\frac{1}{3}ml^2\ddot{\theta} + (k_t + k_1a^2 + k_2l^2)\theta = 0$ **2.86** $m_{eff} = \frac{17}{35}m$ **2.88** $\omega_n = \sqrt{\frac{k}{4m}}$

3.47 $k = 1.0070 \times 10^5$ N/m, $c = 633.4038$ N-s/m