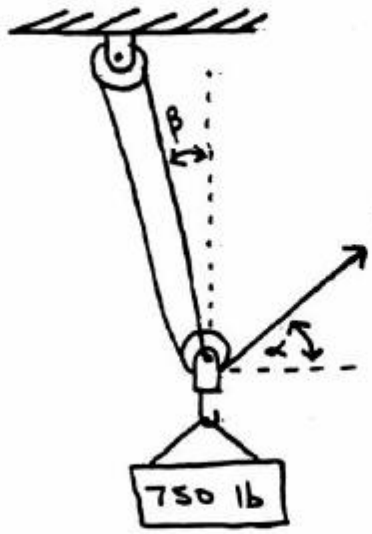
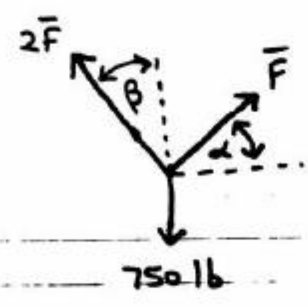
SAMPLE Computer Solution

Problem 2.C2 A 750-lb crate is supported by the rope-and-pulley arrangement shown. Write a computer program which can be used to determine, for a given value of β, the magnitude and direction of the force F which should be exerted on the free end of the rope. Use this program to calculate F and α for values of β from 0 to 30° at 5° intervals.



Solution:

Free Body Diagram: (lower pulley)



750 lb

$$\Sigma F_x = 0 = F\cos\alpha - 2F\sin\beta$$

$$\cos\alpha = 2\sin\beta$$

$$\boxed{\alpha = \cos^{-1}(2\sin\beta)}$$

$$\Sigma F_y = 0 = F\sin\alpha + 2F\cos\beta - 750$$

$$F(\sin\alpha + 2\cos\beta) = 750$$

$$\boxed{F = \frac{750}{\sin\alpha + 2\cos\beta}}$$

Now write a computer program to solve the 2 boxed equations above for $\beta = 0$ to $30°$ in $5°$ increments.

MatLab program:

Editor - F:\Courses\Egr140\MatLab\EGR140_Sample.m

```matlab
% EGR 140 - Statics
% Sample computer solution
% Problem:  A 750-lb crate is supported by a rope-and-pulley arrangement.
% Write a computer program to solve for the force F to be exerted on the
% free end of the rope as angle B (beta) varies from 0 to 30 degrees.
% ------------------------------------------------------------------------
% Steps:
% 1)  Draw Free Body Diagram (see attached sheet)
% 2)  Write the equations of equilibrium and solve for F and A (alpha) as
%     functions of B. (see attached sheet)
% 3)  Use MatLab to evaluate the equations and to graph the results.
% ------------------------------------------------------------------------
clc;
Bdeg=0:5:30;    % Vary B from to to 30 degrees in 5 degree increments
Brad = Bdeg*pi/180;                % Convert angle B to radians
Arad=acos(2*sin(Brad));            % Calculate angle A in radians
Adeg=Arad*180/pi;                  % Convert angle A in degrees
F=750./(2*cos(Brad)+sin(Arad));    % Calculate force F
Result = [Bdeg',Adeg',F']';        % Combine three vectors in a matrix
                                   %    in order to print a table
disp('Angle B(deg)  Angle A (deg)  Force F (lb)'); % Display title
fprintf('%8.2f  %13.2f  %12.2f\n',Result);  %Display the table of values
plot(Bdeg,F,'r+-')                 % Graph Force versus angle B
grid                               % Turn on gridlines
title('Force F versus Angle B')
xlabel('Angle B (deg)')
ylabel('Force F (lb)')
figure                             % Use a new window for Graph 2
plot(Bdeg,Adeg,'bd:')              % Graph angle A versus angle B
title('Angle A versus Angle B')
xlabel('Angle B (deg)')
ylabel('Angle A (deg)')
```

Output from MatLab program:

Command Window

New to MATLAB? Watch this Video, see Demos, or read Getting Started.

Angle B(deg)	Angle A (deg)	Force F (lb)
0.00	90.00	250.00
5.00	79.96	251.92
10.00	69.68	257.97
15.00	58.83	269.06
20.00	46.84	287.49
25.00	32.30	319.56
30.00	0.00	433.01

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>>
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