THE UNIVERSITY OF MICHIGAN-DEARBORN
COLLEGE OF ENGINEERING AND COPUTER SCIENCE
IMSE/CIS 381: INDUSTRIAL ROBOTICS
ASSIGNMENT #3

STUDENT: Demetrius Johnson

1. A part weighing 10 kg. is to be held by a gripper using friction against Four opposing fingers. The coefficient of friction between the fingers and the part is estimated to be 0.25. The orientation of the gripper will be such that the weight of the part will be applied in a direction parallel to the contacting finger surfaces. The factor of safety is 1.5. Compute the required gripper force for each of the following conditions:
   a. A fast working cycle is anticipated so that G factor to be used in force calculation should be 3.0

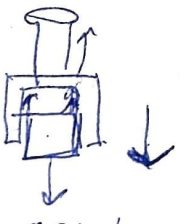
gravity = $9.81 m/s^2$

Part: 10kg; weight = $10kg \cdot 9.81 m/s^2 = 98.1$ Newtons

$n_f = 4$

$\mu = 0.25$

$S_f = 1.5$



Solution $F_g = 441.45N$

$F_g = 294.3N$; Now with Safety Factor of 1.5 $(294.3)(1.5) =$

~~Solution~~

$(F_g)(S_f) = 441.45$

*for $G = 3.0$; Acceleration Force is applied in the same direction as gravity force.

*Calculate F_g: use $wG = \mu \cdot n_f \cdot F_g$; $F_g = \frac{wG}{(\mu)(n_f)} = \frac{(98.1)(3)\,N}{(0.25)(4)}$

   b. The robot motion cycle has been analyzed and it has been found that the largest acceleration experienced by the part held in the gripper is immediately after the pickup. The maximum acceleration is measured as 1200 cm/sec/sec (note g = 981 cm/sec/sec)

Calculate G factor: $G = 1 + a/g = 1 + \frac{1200\ cm/s^2}{981\ cm/s^2} = 2.22$

$F_g = \frac{wG}{(\mu)(n_f)} = \frac{(98.1N)(2.22)}{(0.25)(4)} = 218.1\ N$

with $S_f \Rightarrow (218.1N)(1.5) = 327.15N$

Solution: $F_g = 327.15N$

2. A vacuum pump to be used in a robot vacuum gripper application is capable of drawing a negative pressure of 5.0 lb/in.^{2} compared to atmospheric pressure. The gripper is to be used for lifting stainless steel plates, each plate having dimensions of 15 by 35 in. and weighing 60 lb. Determine the diameter of the suction cups to be used for the robot gripper if it has been decided that three (3) suction cups will be used for the gripper greater stability. A factor of safety of 1.5 should be used in the design computation.

$P = 5\,psi$ per cup

Part Dim: $(15in \times 35in) = 525in^2$

Weight of part = 60 lbs

# of cups = 3 = n

SF = 1.5

Diameter of cup D = ?

use: $F \cdot SF = P \cdot n \cdot A$

$A = \frac{F \cdot SF}{P \cdot n} = \frac{(60lbs)(1.5)}{(5)_{psi} \cdot (3)} = \frac{90lbs}{15psi} = 6in^2$

Area of circle = πr^2; $\pi r^2 = 6in^2$

$r = \sqrt{\frac{6in^2}{\pi}} = 1.38in$; $D = 2r = 2.76in$

Solution: Need D = 2.76in for each cup