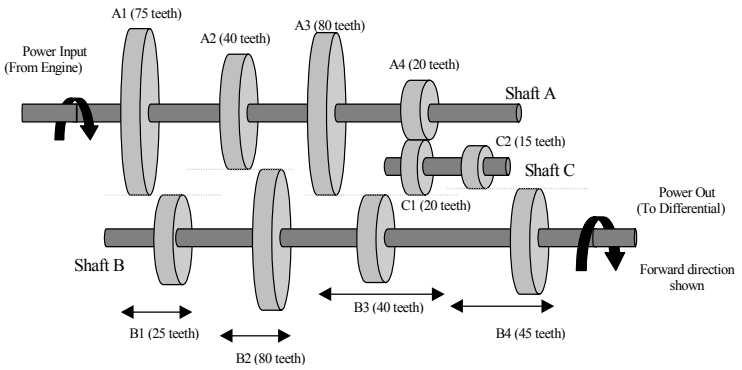
Homework 3

Question 1: A manual transmission is shown below. All gears on Shaft A and Shaft C are fixed to the shaft. Gears A4 are in constant mesh with gear C1. All gears on shaft B are sliding gears. Twenty horsepower at a rotational speed of 2626 rpm is input to shaft A.



a). How many forward gears does this transmission have.

Three Forward gears

b) How many reverse gears does this transmission have.

Two Reverse gears

c) Determine which gears are engaged to obtain the highest gear ratio (forward gears only). What is the output shaft speed (shaft B) for this gear ratio.

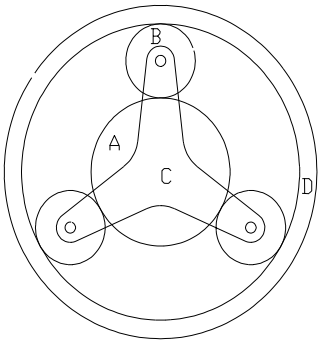
Gear ratio is the ratio of the input speed / output speed. Therefore for highest gear ratio A2 will be engaged to B2:
Gear Ratio = # Output Teeth / # Input Teeth = 80/40 = 2
Output Speed = Input Speed / G = 2626/2=1313 rpm

d) Determine the gear ratio, output speed and direction of rotation (forward/reverse) when gear C2 and B4 are engaged.

Gear Ratio = #C1/#A4 * #B4/#C2 = 20/20*45/15 = 3.
Speed = 2626/3 = 875 rpm (reverse)

Question 2 Consider the following planetary gearset. A clockwise input of 200 rpm at a torque of 10 ft-lb (15 Nm) is applied to the sun gear. The ring gear is locked and does not rotate. Output is taken from the carrier

Planet - 20 teeth
Ring - 100 teeth
For Ring Fixed: Ns/Nc = Tr/Ts + 1
For Carrier Fixed: Ns/Nr = - Tr/Ts
For Sun Fixed: Nr/Nc = Ts/Tr + 1



a) The input to the sun gear is 250 rpm and the required output at the carrier gear is 50 rpm. Determine the number of teeth required on the sun gear? What is the gear ratio?

Required gear ratio = Input Speed / Output Speed = 250 /50 = 5 **Gear Ratio = 5**

Ring Gear Fixed, therefore must use equation 1. Ns/Nc = Tr/Ts + 1. The sun is the input & the carrier the output therfore the equation is already in the correct form for Gear Ratio. ie. Input/Output Speed

5 = Tr/Ts + 1,
5 = 100/Ts + 1
4 = 100/Ts
Ts = 25

b) Assuming an overall efficiency of 95% determine the output power from the planetary.

Using speed of 200 rpm, which was given for the power input

Power Input (kW) = 2πTN/60000
P (kW) = 2*3.142*15*200/60000
= .314 kW

Power out = Power In * efficiency
= .314 * .95
= .298 kW

Alternate:
Torque Out = G * Tin * eff
T (N.m) = 5 * 15 * 0.95
= 71.25 N.m
Output Speed = N/G = 200/5 =40
P (kW) = 2πTN/60000
= 2π*71.25*40/60000
= 0.298 kW

Power Input (Hp) = 2πTN/33000
P (Hp) = 2*3.142*10*200/33000
= 0.38 Hp

Power out = Power In * efficiency
= 0.38 * .95
= 0.361 Hp

Torque Out = G * Tin * eff
T (ft.lb) = 5 * 10 * 0.95
= 47.5 N.m
Output Speed = N/G = 200/5 =40
P (Hp) = 2πTN/33000
= 2π*47.5*40/33000
= 0.361 Hp

Question 3 A clutch is required to transmit 400 N.M of torque. The mean radius of the clutch disk is 400 mm, the coefficient of friction is 0.25, and the clutch has a single clutch plate with 2 torque transmitting surfaces.

a) Given the equation T = Fc * f * rm * n. Determine the clamping force required for this clutch plate.

T = Fc * f * rm * n
400(N.m) = Fc * 0.25 * 0.4 (m) * 2
Fc = 400/.25/.4/2
=2000

b) How many torque transmitting surfaces would be required to transmit 125 kW at 1500 rpm, for a clutch that is identical to the previous clutch except the number of torque transmitting surfaces.

Power Input (kW) = $2\pi TN/60000$
T (N.m) = $P*60000/(2\pi N)$
= $125*60000/(2\pi N)$
=795.77 N.m

T = Fc * f * rm * n
795.77 = 2000*0.25*.4*n
Minimum Theoretical n = 3.97 transmittings surfaces
n= 4 surfaces (That is two clutch plates)