National Exams May 2016

04-Agric-B5, Power Units for Agricultural, Biosystems, and Food Industries

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.

3. Four (4) questions constitute a complete exam paper.

4. Each question is of equal value.

5. All questions require calculation.

Problem 1

a) Assume that you have a fan and an electric motor, but no pulleys. The fan is designed to operate at 500 rpm, and the electric motor operates at 1725 rpm. What sizes of fan Pulley will be needed to operate the fan? Assume the motor pulley is 6.5 cm. What is the ratio of the pulleys diameter and the pulleys speed?

b) A hydraulic pump will be powered by a tractor power take-off(PTO). The pump must turn 2100 rpm, and the PTO operates at 540 rpm. What sizes of sprockets are needed? Assume an 18-tooth sprocket for the pump.

Problem 2

Consider the Farmland tractor with a spray tank mounted on the three-point linkage at the rear. The following data apply:

Weight of spray tank when empty=60 Kg

Center of gravity of the tank and water   =1.5 m from the rear axle

=1.0 m from the ground

(i)   If there is a 210 Kg of water in the tank. What is the weight on the front wheels for the unit moving on horizontal ground?

(ii)   What weight of water can be carried and what will be the tractive coefficient(based on total tractive force) if the unit is moving up a 10 degrees slope and the weight on the front wheels is to not be less thank 4KN?

(iii)   What will be the maximum weight on the front wheels and the tractive coefficient as the tractor empties the spray tank while travelling down a 10 degrees slope?

Problem 3

John's automobile has a three-liter SI V6 engine that operates on a four-stroke cycle at 3600 RPM. The compression ratio is 9.5, the length of connecting rods is 16.6 cm and the engine is square (cylinder bore (B)= Stroke(S)). At this speed combustion ends at 20° a TDC (Top Dead Center). Calculate

1. The cylinder bore and stroke length
2. The average piston speed
3. The clearance volume of one cylinder

Problem 4

A pump delivers gasoline at 20°C and 12 m^3/h. At the inlet, p_1 = 100 kPa, z_1 = 1 m, and V_1 = 2 m/s. At the exit p_2 = 500 kPa, z_2 = 4 m, and V_2 = 3 m/s. How much power is required if the motor efficiency is 75%? For gasoline, take $\rho\, g \approx 680(9.81) = 6671$ N/m^3.