National Exams May 2015

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) A hydraulic pump will be powered by a **tractor power take-off** (PTO). One can assume that the driven sprocket is the pump and the driver sprocket is the PTO. It was demonstrated that the product of the rotation by the number of teeth for the pump is equal to the one for the PTO. The pump must turn at 2100 rpm, and the PTO operates at 540 rpm. What size of driver sprocket is needed? Assume an 18-tooth sprocket for the pump. Discuss your results.

b) 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 size of 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 ratio of the pulleys speed? Discuss your results

Problem 2

The unit of engine power in the SI system is the kilowatt. Piston bore and stroke are measured in millimeters. Displacement is reported in liters and the pressure is measured in kiloPascals. The engine power varies linearly with the pressure (P), the stroke(S), the piston area (A), the number of cylinder (n) and the speed (N) as follows

$$E_{Kw} = \frac{P \, x \, S \, x \, A \, x \, N}{60,000 x 2} \, x \, n$$

a) Determine the indicated engine power for an engine in units of KW that has a mean effective pressure of 1050 kPa. The engine is a four stroke cycle engine and has three cylinders. The bore (B) is 109 mm, the stroke (S) is 115 mm and the speed is 3000 rpm.

b) Calculate the piston displacement

c) The compression ratio depends on the piston displacement and the clearance volume. Calculate the compression ratio for the engine if the clearance volume is 0.063124 L. Discuss your results.

Problem 3

When the sound Level is constant over the entire work shift, the noise dose known as D varies linearly with the total length of the work day exposure (C) and inversely proportional to the reference duration level corresponding to the measured sound level (T). The reference duration level T is computed using the following equation

$$T = \frac{8}{2^{(L-90)/5}}$$

Where L is the dBA exposure.

a) Determine the noise dose for an individual who was subject to a sound of 55 dBA for 1.25 hour.
b) Repeat the calculation for a level of 105 dBA for 5 minutes and discuss your results.

Problem 4

How much usable power is available if the basic engine rating is 75 hp and the engine will use a fan and a radiator for cooling? Assume derating 10% for the accessories and 5% for the fan.