BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

AEH 307

Department of Engineering and Physics

Bachelor of Science Honours Degree in Agricultural Engineering

Agricultural Tractors

3 hours (100 Marks)

OCT 2024

Instructions:

1. This paper contains 6 questions
2. Answer any **FOUR** questions, each of which carries 25 marks

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Question 1

a) Distinguish between a single axle reduction and a double axle reduction in tractor final drives. [6 marks]

b) State one application of each of the reduction axle in (a). [4 marks]

c) Describe the advantage provided by an inboard axle reduction. [6 marks]

d) Explain the function of a portal/drop hub gear reduction axle. [3 marks]

e) Explain the benefits of having a drop gear hub reduction on a tractor. [4 marks]

f) Explain the limitations derived from a drop gear hub reduction axle. [2 marks]

Question 2

a) Explain the function of a differential. [4 marks]
b) Outline two limitations of a differential. [8 marks]
c) A 25 HP tractor is running at 100 rpm, total reduction of speed is 10:1. The diameter of the driving wheels is 1.32 m. Calculate:
   i. The speed (rpm) of the final drive wheels, [4 marks]
   ii. The torque (Nm) developed by the tractor, [5 marks]
   iii. The tractive force (N) at each driving wheel. [4 marks]

Question 3

a) The indicated power of a combustion engine is a function of the bore, stroke and speed. Derive the formula for the indicated power of a combustion engine and define its parameters. [5 marks]
b) A tractor has 1.5 meter rear wheel diameter. The final drive gear ration is 5:1 differential gear ratio is 3:1and gear box reduction is 2:1. Calculate the travelling speed of the tractor when the speed of the engine is 1250 rev/min. [8 marks]
c) Explain the need for the use of dual wheels on a tractor. [5 marks]
d) With reference to ballasting on tractors
   i. Explain the need for ballasting. [4 marks]
   ii. State the most common types of ballasts. [2 marks]
   iii. Explain the operations where it is important. [1 marks]

Question 4

a) Sketch and clearly label the theoretical pressure-volume diagram for a compression ignition engine. [5 marks]
b) Explain what is happening at each stage of the cycle in (a). [10 marks]
c) A six cylinder engine has a bore of 70 mm and a stroke of 80 mm. If the clearance volume of one cylinder is 42 000 mm^3, calculate:
   i. The compression ratio. [5 marks]
   ii. The capacity of the engine in litres. (1 litre = 10^6 mm^3). [5 marks]

Question 5

a) Explain the function of the following components in a hydraulic system.
   i. Accumulator, [2 marks]
   ii. Valves, and [2 marks]
   iii. Pump. [2 marks]
b) Outline the distinctions between internal and external hydraulics of a tractor. [4 marks]
c) Outline four advantages of using oil in hydraulic power transmissions. [4 marks]

d) Describe the following hydraulic controls for hitches.
   i. Nudging system [2 marks]
   ii. Position control system. [2 marks]
   iii. Draft control system. [2 marks]

e) With the aid of a diagram distinguish between a single acting and a double acting hydraulic cylinder. [5 marks]

Question 6

a) Outline the functions of a vehicle suspension system. [6 marks]

b) Explain the following components of a vehicle suspension assembly:
   i. Road springs [3 marks]
   ii. Dampers, [3 marks]
   iii. Suspension linkage. [3 marks]

c) Explain three factors limiting the pulling performance of tractors. [6 marks]

d) Given the following conditions.
   - Tractor weight of 28.5 kN
   - Distance from center of gravity to rear axle = 658 mm
   - Drawbar height is 580 mm.

Calculate the critical pull. [4 marks]