



**UNIVERSITY OF SWAZILAND
FINAL EXAMINATION PAPER**

PROGRAMME: BSC ABE. II

COURSE CODE: ABE 203

TITLE OF PAPER: FARM POWER

TIME ALLOWED: TWO (2) HOURS

SPECIAL MATERIAL REQUIRED: NONE

**INSTRUCTIONS: ANSWER QUESTION ONE AND ANY TWO
OTHER QUESTIONS.**

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GRANTED BY THE CHIEF INVIGILATOR**

SECTION I COMPULSORY

QUESTION 1

- a) Discuss the preference of a two stroke engines over four stroke engines in small hand held farm machines. [10 marks]
- b) Figure 1 shows the combustion process in a two stroke engine. State the energy transformations (energy forms) that take place from the energy in the fuel to the energy at the crankshaft. [8 marks]

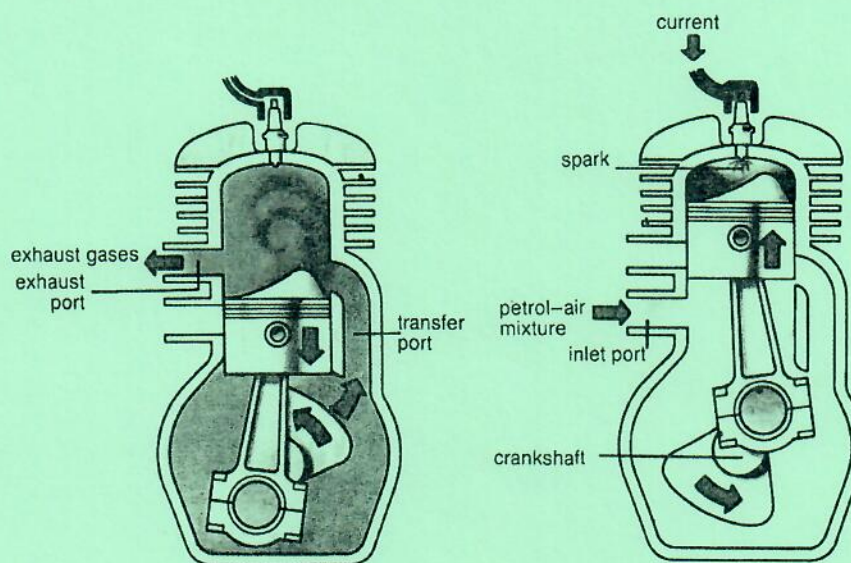


Figure 1 Charge flow processes of a two stroke cycle engine.

- c) What advantages have encouraged the use of chain and sprocket transmission in agricultural machinery? [12 marks]
- d) Figure 2 shows the arrangements of components of a drive train of tractor power transmission system. Table 1 shows the transmission data from the technical specifications of the operator's manual for the components in Figure 2.

Determine the appropriate gear lever positions to be selected for the ploughing operation if maximum engine torque is produced at 1400 rpm and a forward speed of 5 kmph. (A forward speed of 5 kmph requires the rear wheels to rotate at 7 rpm). [10 marks]

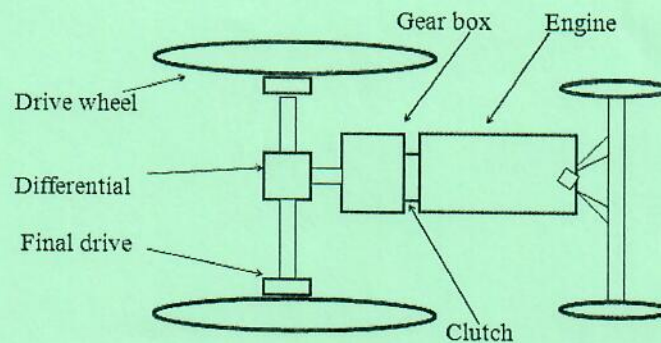


Figure 2 Drive train of a tractor transmission.

Table 1 Tractor data sheet

Tractor component		Gear ratio	
Range gear lever selector (positions)		L	H
Main gear lever selector (positions)	1	8:1	4:1
	2	7:1	3:1
	3	6:1	2:1
	4	5:1	1:1
Differential		8:1	
Final drive		5:1	

SECTION II**ANSWER ANY TWO QUESTIONS****QUESTION 2**

- Distinguish between motion transmission and motion transformation of machinery elements [4 marks]
- List any three power transmission systems and three power transformation systems. [6 marks]
- Discuss the recent increase in the use of hydraulic power transmission systems in agricultural machines. [10 marks]
- A span of draught oxen generates a pull in the chain of 1.21 kN when walking steadily in the field at an average speed of 0.9 m/s. Given that the angle of the chain is 16° to the horizontal, calculate:
 - Draught force. [5 marks]
 - The power generated by the oxen. [5 marks]

QUESTION 3

- a) "Solar energy is widely used by farmers on the Swazi Nation Land".
 - i) Do you agree or disagree with the above statement? [2 marks]
 - ii) Justify your answer in i) above. [5 marks]

- b) Discuss the low demand for biological sources of energy (human beings and animals) in accomplishing farm tasks despite being classified as renewable sources of farm power? [5 marks]

- c) Explain why electrical energy is neither renewable nor non-renewable source of energy? [5 marks]

- d) Figure 3 shows a wind mill for pumping water from underground. A farmer's borehole requires 2.0 kW of power to pump out water. Determine
 - i) The kinetic energy of the wind mass as it approaches the blades? [5 marks]
 - ii) The power that the windmill can provide, if the wind leaves with 20% of the kinetic energy at entry; [2 marks]
 - iii) Is the available windmill able to pump water? [2 marks]
 - iv) If the answer in iii) is yes, what would be the minimum diameter of blades to just provide enough energy to pump out water? [4 marks]
 - v) If the answer in iii) above is no, what should be the minimum diameter of blades required to power the pump? [4 marks]

Kinetic energy in the wind is given by $\frac{1}{2} \rho Av^3$

Where A = swept area of blades

v = wind speed.

ρ = air density

Given values are:

Rotor diameter D=3 m

Wind speed v = 9 m/s

Air density $\rho = 1.2 \text{ kg/m}^3$

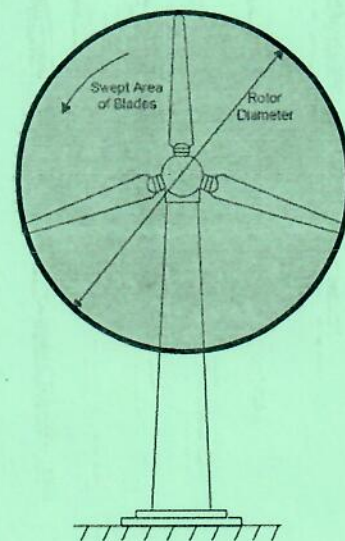


Figure 3 Wind turbine for pumping water.

QUESTION 4

- a) Figure 3 shows steering of different axles of four wheel drive tractors. Name the four different steering techniques. [8 marks]

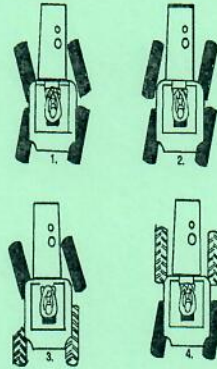


Figure 3 steering of four wheel drive tractors.

- b) Discuss the preference of hydraulic power systems heavy agricultural machinery operations. [10 marks]
- c) The steering axle of a tractor is mounted with a hydraulic cylinder whose diameter is 50 mm. If a steering load of 20 kN is to be overcome, determine the
- pressure that the hydraulic pump should provide. [6 marks]
 - hydraulic power of the pump if a discharge of 50 L/min flows to the cylinder. [6 marks]