



EGERTON

UNIVERSITY

UNIVERSITY EXAMINATIONS

NJORO CAMPUS

SECOND SEMESTER, 2013/2014 ACADEMIC YEAR

THIRD YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN  
AGRICULTURAL ENGINEERING

AGEN 333: TRACTORS & THEIR POWER UNITS

STREAM: BSC AGEN

TIME: 2 HOURS

DAY: THURSDAY, 3.00 – 5.00 PM

DATE: 22/05/2014

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**INSTRUCTIONS**

- This examination paper has TWO sections (A & B)
- Answer ALL questions in Section A and ANY TWO questions in Section B
- Marks for each part of a question are as shown
- You should have a calculator and drawing instruments for this examination.

**SECTION A**

1. (a) State
  - (i) Four differences between a compression ignition engine and a spark ignition engine. (4 marks)
  - (ii) Two differences between a four stroke cycle spark ignition engine and a two stroke cycle spark ignition engine. (2 marks)
- (b) Explain why the stroke-to-bore ratio has decreased over the years in the design of engines. (2 marks)

(c) (i) What causes combustion noise or diesel knock in a compression ignition engine

(1 mark)

(ii) What factors suppress diesel knock?

(1 mark)

(d) With the aid of sketches briefly explain

(i) The main design features of a crank shaft.

(3 marks)

(ii) The combustion chamber design of direct and indirect compression ignition engines.

State one advantage and one disadvantage for each of the combustion chamber designs.

(4 marks)

(e) A fuel represented by the hydrocarbon  $C_{16}H_{34}$  is used in an engine. For a mixture strength of 120%, determine:

(i) The air/fuel ratio

(ii) The wet analysis by volume of the exhaust gases

(13 marks)

$$\text{Mixture strength} = \frac{\text{Stoichiometric } A/F \text{ ratio}}{\text{Actual } A/F \text{ ratio}}$$

Assume that

- Air contains 21% oxygen by volume, 23.3% oxygen by weight
- All oxygen is burned to  $H_2O$  and Carbon in fuel will burn to  $CO_2$  and  $CO$ .

2. (a) (i) Sketch a pv diagram for the ideal air standard cycle for the petrol engine.

(2 marks)

(ii) Show that the thermal efficiency for the cycle in (i) above depends only on

compression ratio.

(7 marks)

(iii) Define the term 'mean effective pressure'. Use a pv diagram to illustrate your answer.

(2 marks)

- (b) A four cylinder four stroke cycle S.I engine has a bore of 65 mm and a stroke of 65 mm. When tested against a brake which has a torque arm of 0.356 m, at a rated speed of 40 rev/second, the brake load is 160N and the fuel consumption 90 mL/minute. The fuel has a lower calorific value  $\delta_{net}$ ,  $Q_{net,v}$  of 44200 kJ/kg and specific gravity of 0.724. When a morse test is carried out the following results are obtained.

| Cylinder cut out | Brake load (N) |
|------------------|----------------|
| 1                | 112            |
| 2                | 115            |
| 3                | 109            |
| 4                | 113            |

For the given rated speed, determine:-

- (i) Brake mean effective permute
  - (ii) Brake thermal efficiency ✓
  - (iii) Specific fuel consumption ✓
  - (iv) Mechanical efficiency ✓
- (12 marks)

Also estimate the volumetric efficiency of the engine if an analysis of the exhaust showed no oxygen and negligible Carbon Monoxide. The engine was tested at  $1.013 \times 10^5 \text{ N/m}^2$  and  $10^0 \text{ C}$

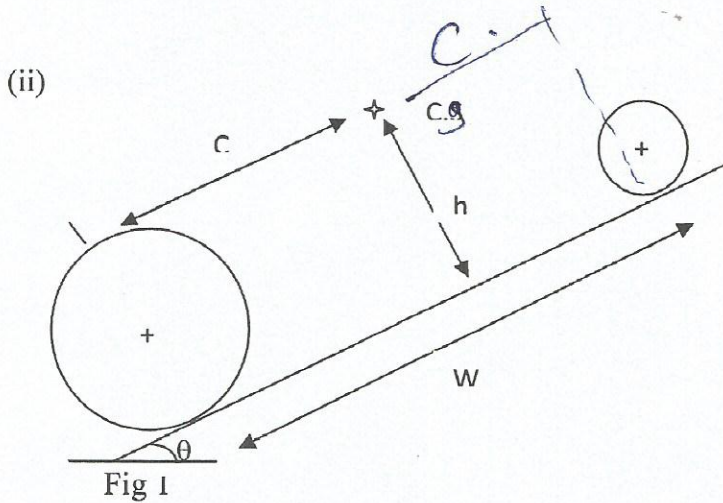
**Assume**

Air/Fuel ratio 14.5/1

PV/MRT and R for air = 0.287 kJ/Kg. (7 marks)

**SECTION B**

- ③ (a) (i) With the aid of sketches, illustrate the two stages of lateral instability for a conventional four-wheel tractor with pivoting front axle. (4 marks)



Show that for the tractor in fig 1, the maximum slope  $\theta$  up which the tractor can move

before wheel slip is given by  $\tan^{-1} \frac{\mu(\omega - c)}{\omega - \mu h}$  (6 marks)

(b) Briefly discuss TWO GROUND conditions and TWO DRIVER controlled characteristics that can lead to tractor overturning accidents in the field. (4 marks)

(c) Briefly explain how the following are useful in the prevention of tractor overturning accidents in the field.

- (i) Ballast
  - (ii) Mounted implements
  - (iii) 2 WD or 4 WD tractors
- (6 marks)

4. (a)

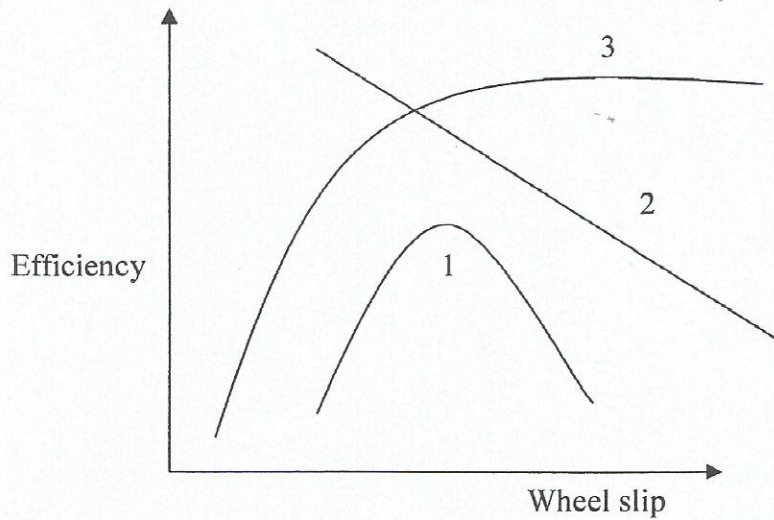


Fig 2

Fig 1 shows the variation with wheel slip of a drive wheel with

- ground drive efficiency
- thrust utilization efficiency
- forward travel efficiency

(i) Which curve represents which efficiency factor?

(ii) For forward travel efficiency explain why it has the general shape shown.

(4 marks)

(b) A tractor is to pull a 3-furrow mounted plough in firm soil.

**Given:**

- Plough bottom cuts 200 mm deep and 300 mm wide
- Soil resistance is  $35 \text{ kN/m}^2$
- Actual forward speed is 6.4 km/hr

- Static rear axle loading is 9.7 KN
- Static front axle loading is 7.0 KN
- Transmission efficiency is 90%

**Find**

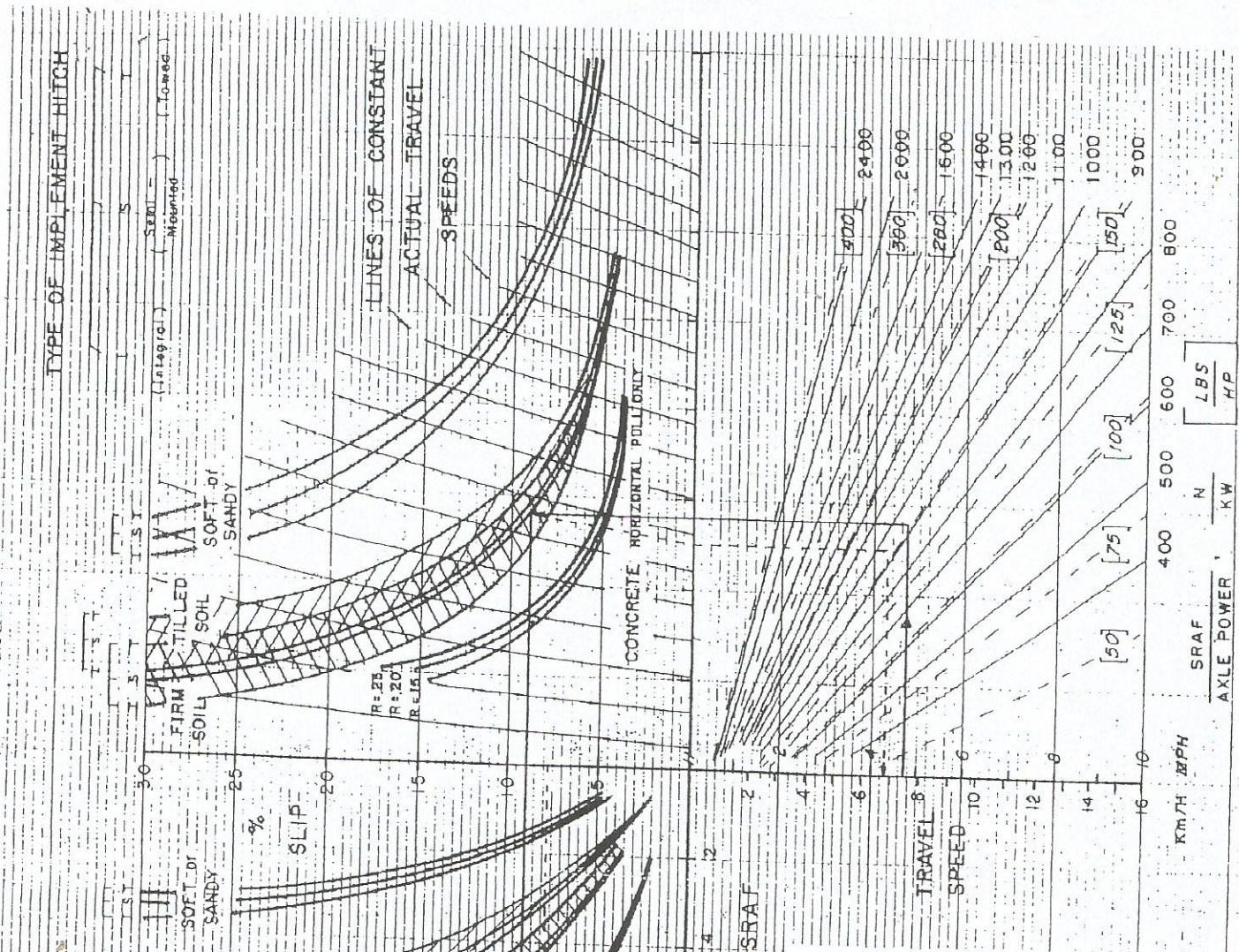
- (i) The drawbar power developed
- (ii) The expected wheel slip
- (iii) Ground drive efficiency of  $\eta_{gd} = \frac{\text{drawbar power}}{\text{Axle power}}$
- (iv) Engine power developed
- (v) Possibilities of utilizing a greater proportion of the total engine power (stated as 34 KW)
- (vi) Effect of a 8° slope

Attach the Tractor drawbar performance predictor chart to your answer.

(16 marks)

5. Describe how the longitudinal and vertical location of the centre of gravity of a tractor can be determined using the weighing method. State any assumptions made.(20 marks)

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2.11. Tractor drawbar performance predictor. Limited to two rubber traction on rear-axle-drive tractor having gear transmission. The coefficients of dynamic weight transfer on soils are 0.65 for I, 0.45 for S, and 0.25 for T implement bases. For concrete the coefficients are given as R, the ratio of drawbar height to wheelbase. Zero slip is defined at zero pull. Axle power = approximately 0.96 P.P. SRAF = static rear axle force.