EGERTON UNIVERSITY

UNIVERSITY EXAMINATIONS

NJORO CAMPUS

SECOND SEMESTER 2012/2013

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

AGEN 333: TRACTOR AND THEIR POWER UNITS

STREAM: 2010 (Y3) B. SC. AGEN **TIME:** 2 hours

DAY/TIME: TUESDAY, 03.00- 05.00 pm **DATE:** 14-05-2013

INSTRUCTIONS:

1. The paper consists of **FIVE (5)** questions.
2. Attempt **ANY FOUR** questions.
3. All questions carry equal marks.
4. Marks for each question are shown in parenthesis.
5. In case of calculations, show all the working steps as well as the relevant units and indicate any assumptions made.
6. **EACH QUESTION SHOULD BE STARTED ON A NEW PAGE.**

QUESTION ONE

(a) Sketch a P-V diagram for:

(i) The ideal air standard OTTO cycle for a petrol engine

(ii) An actual petrol engine

Name the processes. **(6 marks)**

(b) Show that thermal efficiency for the ideal air-standard cycle for a petrol engine depends only on compression ratio. **(4 marks)**

(c) A four cylinder four stroke cycle spark ignition engine has a bore of 65 mm and a stroke of 70 mm. When tested against a brake which has a torque arm of 0.365 m, at a rated speed of 2000 rev/min.,

the net brake load is 162 N and the fuel consumption 86 ml/min. The fuel has a lower calorific value Q_{nets} 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
1	114
2	109
3	115
4	112

For the given rated speed, determine the;

(i) Brake mean effective pressure. **(2 marks)**

(ii) Brake thermal efficiency **(2 marks)**

(iii) Specific fuel consumption. **(2 marks)**

(iv) Mechanical efficiency. **(5 marks)**

Also estimate the volumetric efficiency of the engine if an analysis of the exhaust should show no oxygen and negligible carbon monoxide given the following:

- The engine was tested in an atmosphere at 10^5 N/m^2 and 10°C.

Assume:

- Air/fuel ratio is 14.5/1
- PV = MRT and R for air = 0.287 x 10^3 kJ/kg **(4 marks)**

QUESTION TWO

(a) What are the differences between:

(i) A compression ignition engine and a spark ignition engine? **(4 marks)**

(ii) A four stroke cycle spark ignition engine and a two stroke cycle spark ignition engine? **(2 marks)**

(b) The cycle and thermal efficiencies of both compression ignition and spark ignition engines increase with increased compression ratio. What limits the use of higher compression ratios in these engines? **(4 marks)**

(c) With the aid of a sketch(es) explain the main features of an engine crankshaft. **(4 marks)**

(d) A fuel represented by the hydrocarbon C_6H_{14} is to be used in an engine.

(i) Determine the stoichiometric A/F ratio. **(5 marks)**

(ii) Estimate the percentage analysis of dry exhaust gases if 10% less air than theoretically required for complete combustion is used. Assume that air contains 21% oxygen by volume and 23.3% oxygen by weight. **(6 marks)**

QUESTION THREE

(a) Explain how the following are important in the prevention of tractor overturning accidents in the field.

(i) Mounted implements.

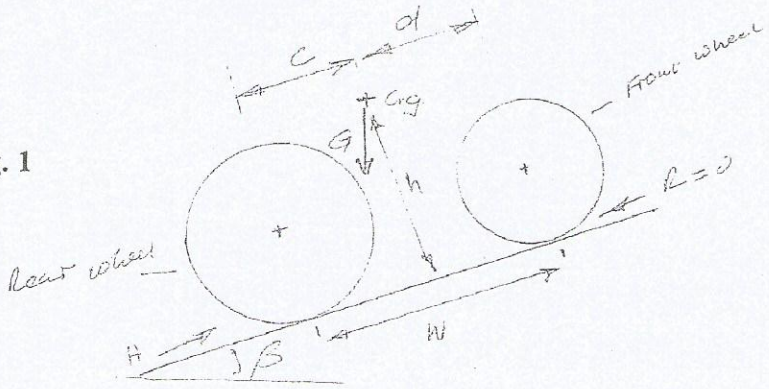
(ii) Weight addition on wheels.

(iii) Four wheel (4WD) drive tractor. **(6 marks)**

(b) Briefly explain two ground conditions that can lead to tractor overturning accidents in the field. **(4 marks)**

(c) Show the two stages of lateral instability for a conventional four-wheel tractor with pivoting front axle. **(4 marks)**

Fig. 1



c.g - centre of gravity
H – thrust
R – rolling resistant
G – tractor weight

(i) Show that the minimum slope 'β' up which the tractor in fig 1 can move before wheel slip is given by $\beta = \frac{\tan^{-1} \mu (w-c)}{(w-\mu h)}$ **(7 marks)**

(ii) Derive the equation for the maximum slope up which the tractor in **Fig 1** can move before over-turning rear ward. **(4 marks)**

QUESTION FOUR

Describe how the location of the centre of gravity of a tractor can be determined. State any consumptions made in this determination. **(25 marks)**

QUESTION FIVE

(a)

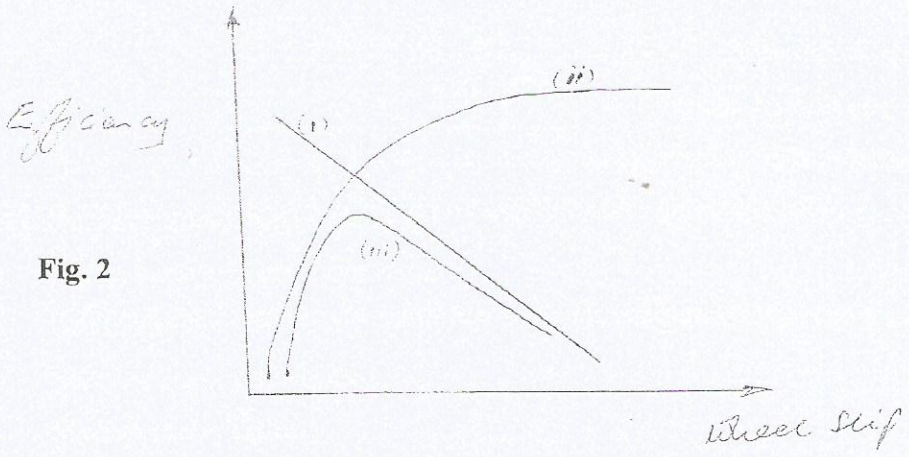


Fig. 2

Fig 2 above shows variation with wheel slip of a drive wheel with:

- Ground drive efficiency
- Thrust utilisation efficiency.
- Forward travel efficiency

Which curve represents which efficiency factor? **(3 marks)**

(b) A tractor pulls a two furrow mounted disc plough in firm conditions. Given the following information:

- Each plough bottom cuts 30 cm wide and 20 can deep.
- Specific soil resistance is 60 kN/m^2
- Speed of working is 5.5 km/hr.
- Static rear axle lading is 9.7 kN.
- Tractor weight 16.7 kN.

With the assistance of the tractor draw bar performance predictor chart find:

(i) Expected wheel slip

(ii) Drawbar power

(iii) Engine power used. **(16 marks)**

If part of the field has a 3° slope, find:

(iv) Wheel slip expected working of this slope.

(v) Ballast needed to reduce the wheel slip to 12%. **(6 marks)**

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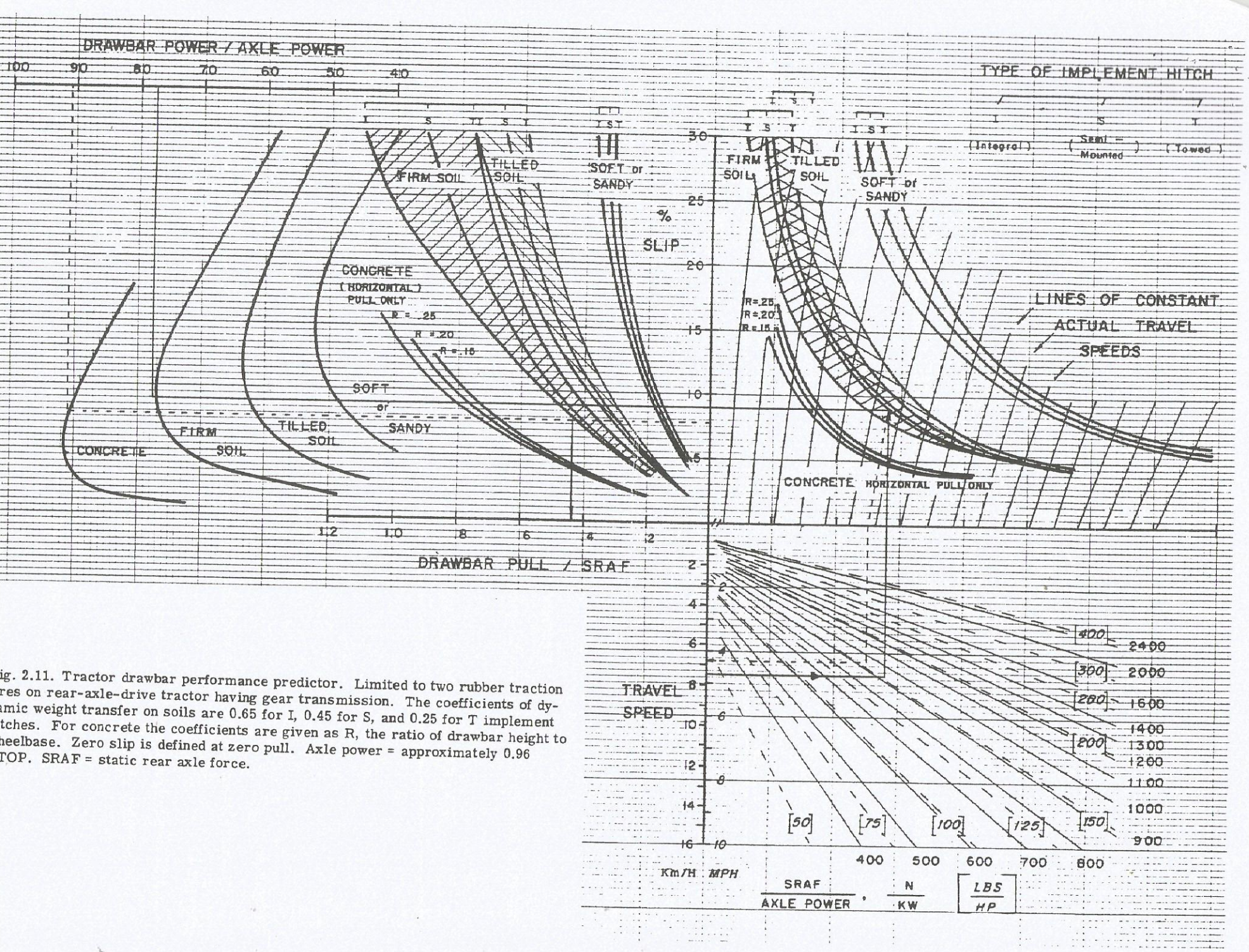

ig. 2.11. Tractor drawbar performance predictor. Limited to two rubber traction res on rear-axle-drive tractor having gear transmission. The coefficients of dy- amic weight transfer on soils are 0.65 for I, 0.45 for S, and 0.25 for T implement tches. For concrete the coefficients are given as R, the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