

**AGRICULTURAL AND FOOD ENGINEERING DEPARTMENT  
IIT KHARAGPUR**

**Mid-Spring Semester Examination 2017-2018  
3<sup>rd</sup> Yr. B.Tech. (Hons.) & Dual Degree**

**Date of Exam: 19-02-2018 (02:00-04:00 PM)**

**Max. Marks: 30**

**Subject No.: AG31002**

**Time: 2 hr.**

**Subject Name: Tractor & Power Systems**

**No. of Students: 55**

**Instruction: Answer all the questions. Answer must be brief and to the point. Make justified assumptions wherever necessary.**

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1. Consider the piston movement in a 4S-diesel engine as a function of crankshaft rotation as given by the following equation

$$\frac{S}{R} = [1 - \cos \theta] + \frac{L}{R} \left[ 1 - \sqrt{1 - \left(\frac{R}{L} - \sin \theta\right)^2} \right]$$

Where, S = piston displacement from HDC, m

R = crank throw radius, m

$\theta$  = crankshaft position, radians (measured from HDC)

L = connecting rod length, m

- (i) Compute the approximate piston velocity, make justified assumptions. [2]
- (ii) At what angle of the crankshaft rotation, the maximum piston speed will be obtained? [2]
- (iii) Calculate the piston acceleration in  $m/s^2$ . At what point is the piston acceleration maximum? [2]
- (iv) If 'm' is the translational mass in 'kg' compute the piston inertia force. [2]
- (v) Will the acceleration change if a 2-S engine is considered? [1]
- (vi) (a) If  $L/R = 3.0$  plot the normalized piston velocity ( $V/R\omega$ ) (where  $\omega$  is angular crankshaft speed) for one complete revolution of the crankshaft. [2]
- (b) On the same graph, mark the crank angle at which maximum piston velocity occurs. [2]
- (c) Does the crank angle of (b) agree with the maximum velocity plot of (a)? [2]
2. (i) What is a DI engine? Explain its constructional difference with an IDI engine. Enumerate the associated advantages and disadvantages of IDI & DI engines. What is the role of fuel used in these engines so far as the thermal efficiency is concerned? [4]
- (ii) A 3-litre, naturally aspirated CI engine is running on No.2 diesel fuel with a stoichiometric A/F ratio of 15. The air temperature is  $20^\circ\text{C}$  and the barometric pressure is 98 kPa. The  $P_{bme}$  is 700 kPa and the BSFC is 0.25 kg/kWh at rated speed and power. The high idle speed is 2540 rpm and the rated speed is 2400 rpm.

- (a) Calculate the ambient air density.
- (b) Assuming the cylinders are able to fill to 85% of capacity with ambient air, calculate the air consumption of the engine in kg/hr when the engine is running at a high idle speed.
- (c) As (b), but when the engine is running at rated speed.
- (d) Calculate the fuel consumption in kg/h at rated speed.
- (e) Calculate the equivalence ratio of the mixture at rated speed.
- (f) Assuming that the fuel consumption rate falls to 2.6 kg/h at high idle, calculate the equivalence ratio at high idle. Note that this wide change in equivalence ratio of the CI engine is in sharp contrast to that of the SI engine, in which the equivalence ratio stays relatively close to unity for homogenous mixing.

[6]

(iii) Write short notes on:

- (a) Coefficient of fluctuation of energy
- (b) Volumetric efficiency of diesel engine
- (c) Fuel cut-off ratio

[5]

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