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Paper Code : ME-601

IC ENGINE & GAS TURBINE

Time Allotted : 3 Hours | *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

i) Brake specific fuel consumption is defined as

a) Rate of fuel consumption per hour

b) Rate of fuel consumption per km

c) Rate of fuel consumption per bp

d) Rate of fuel consumption per cycle.

ii) Equivalence ratio is

a) $\frac{\text{actual } \frac{F}{A} \text{ ratio}}{\text{stoichiometric } \frac{F}{A} \text{ ratio}}$

b) $\frac{\text{stoichiometric } \frac{F}{A} \text{ ratio}}{\text{actual } \frac{F}{A} \text{ ratio}}$

c) $\frac{\text{stoichiometric } \frac{F}{A} \text{ ratio}}{\text{actual } \frac{A}{F} \text{ ratio}}$

d) $\frac{\text{actual } \frac{A}{F} \text{ ratio}}{\text{stoichiometric } \frac{F}{A} \text{ ratio}}$

iii) Advantage of two-stroke engine is

a) more uniform torque

b) lighter flywheel

c) no valves

d) all of these.

iv) The volumetric efficiency of a well designed engine is in the range of

a) 30% to 40%

b) 40% to 60%

c) 60% to 70%

d) 75% to 90%.

v) Thermal efficiency varies

a) inversely as *sfc*

b) directly as *sfc*

c) as square of *sfc*

d) as square-root of *sfc*.

vi) Stirling engine can be called as

a) Internal combustion engine

b) External combustion engine

c) Combination of internal and external combustion engine

d) none of these.

vii) Which is the most effective alternative fuel for IC Engine in rural area ?

a) CNG b) Bio-gas

c) Alcohol d) Hydrogen.

viii) In a carburetor, idling system is used

a) to compensate for dilution of change due to residual gases

b) for cold starting

c) for meeting maximum power requirements

d) for rapid opening of throttle.

ix) On which factor out of the following volumetric efficiency does not depend ?

a) Speed of engine b) Compression ratio

c) Clearance volume d) Cylinder dimensions.

x) Piston rings are usually made of

a) Aluminium alloy b) Cast iron

c) Cast steel d) Forged iron.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. Explain briefly about different types of fuel injection nozzles with their merits, drawbacks and figures.
3. Define relative efficiency. Determine the effect of % change in efficiency of Otto cycle having a compression ratio 8 if the specific heat at constant volume increases by 2%.
4. An engine develops a brake power of 3·68 kW. Its indicated thermal efficiency is 30%, mechanical efficiency is 80%. Calorific value and specific gravity of the fuel are 42 MJ/kg and 0·875 respectively. Calculate (i) fuel consumption of the engine in kg/h and litres/h. (ii) indicated specific fuel consumption and (iii) brake specific fuel consumption.
5. Derive the expression for maximum net work in a GT cycle in terms of maximum & minimum temperature of the cycle.
6. Explain with sketches the working of a battery ignition system.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) Briefly explain the major losses in actual cycles. Write the differences between the actual and air-standard cycles.

b) The compression ratio and expansion ratio of an oil engine working on the dual cycle are 9 and 5 respectively. The initial pressure and temperature of the air are I bar and 30°C. The heat liberated at constant pressure is twice the heat liberated at constant volume. The expansion and compression follow the law $PV^{1.25}$ constant. Determine —

i) Pressures and temperatures at all salient points

ii) Mean effective pressure of the cycle

iii) Efficiency of the cycle

iv) Power of the engine,

if working cycles per second is 8, cylinder bore = 250 mm and stroke length = 400 mm.

(3 + 3) + 9

8. a) Write a short note on MORSE test.

b) The following results were obtained during a test of a 4 stroke, 4 cylinder petrol engine of 100 cc clearance volume, 75 mm bore & 100 mm stroke : B.P. with all cylinders working = 15·6 kW, B.P. with cylinder no. 1 cut out = 11·1 kW, B.P. with cylinder no. 2 cut out = 11·03 kW, B.P. with cylinder no. 3 cut out = 10·88 kW, B.P. with cylinder no. 4 cut out = 10·66 kW, calorific value of the fuel = 45000 kJ/kg.

Calculate (i) mechanical efficiency, (ii) indicated thermal efficiency, (iii) air standard thermal efficiency, (iv) brake thermal efficiency, (v) frictional losses.

5 + 10

9. a) In a closed cycle gas turbine, air enters the compressor at 1 bar, 27°C where pressure ratio is 6. Maximum temperature in the cycle is limited to 700°C. The isentropic efficiencies of the compressor and the turbine are 0·82 and 0·85 respectively. Find the following :
(i) the compressor work per kg of air, (ii) the turbine work per kg of air, (iii) the heat supplied per kg of air, (iv) cycle efficiency, (v) the turbine exhaust temperature.
If a regenerator of 90% is employed in the cycle, find the change in cycle efficiency.

b) For a specified pressure ratio, why does multistage compression with intercooling decrease the compressor work, and multistage expansion with reheating increase the turbine work? 10 + 5

10. a) An unknown hydrocarbon fuel C_xH_y was allowed to react with air. An analysis was made of a representative sample of the product gases with the following result :
$CO_2 = 12·1\%$, $O_2 = 3·8\%$, $CO = 0·9\%$.

Determine —
i) the chemical equation for the actual reaction
ii) the composition of the fuel
iii) the air-fuel ratio during the test
iv) the excess or deficiency of air used.