Code No: R2022033 **R20** **SET - 1**

II B. Tech II Semester Regular/Supplementary Examinations, July - 2023

THERMAL ENGINEERING-I

(Mechanical Engineering)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) An air-standard diesel cycle has a compression ratio of 16 and the heat transferred to the working fluid per cycle is 1500 kJ/kg. At the beginning of the compression stroke, the pressure is 1 bar and the temperature is 300 K. Calculate the thermal efficiency and mean effective pressure. [7M]

b) Discuss the actual and fuel-air cycles of CI engines. [7M]

Or

2 a) A spark-ignition engine working on ideal otto cycle has the compression ratio 6. The initial pressure and temperature of air are 1 bar and 37^{o}C respectively. Calculate the theoretical thermal efficiency of this cycle if the pressure at the end of the adiabatic compression is 18 bar. Peak temperature during the cycle is 1800K. Calculate [7M]
   (i) The heat supplied per kg of air,
   (ii) The work done per kg of air,
   (iii) The pressure at the end of adiabatic expansion.
   Take C_v = 0.818kJ/kgK and γ = 1.4.

b) List out and explain in detail about the various factors that influence the engine performance. [7M]

UNIT-II

3 a) What is lubrication? Why is lubrication required? Explain various properties of a lubricant in detail. [7M]

b) What is a supercharger? Explain how supercharging process is carried out in S.I. and C.I. engines. [7M]

Or

4 a) Explain the construction and working principle of Wankel engine with a neat sketch. [6M]

b) Following are the data of a four-cylinder four stroke petrol engine. Air-fuel ratio by weight = 16:1, calorific value of the fuel = 46000 kJ/kg, mechanical efficiency = 80%, air-standard efficiency = 55%, relative efficiency = 70%, volumetric efficiency = 75%, stroke/bore ratio = 1.25, suction conditions = 1 bar 27^{o}C, rpm = 2400 and power at brakes = 70 kW. [8M]
   (i) Compression ratio,
   (ii) Indicated thermal efficiency,
   (iii) Brake specific fuel consumption,
   (iv) Bore and stroke.

UNIT-III

5 a) What do you mean by normal combustion? What are the various factors that effect the normal combustion in spark ignition engines? [7M]
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b) Explain different stages of combustion in C.I. engines. [7M]

Or

6 a) Discuss the important qualities that are required for the fuel for S.I. engines. [7M]

b) What are the various types of nozzles employed in C.I. engines? Explain briefly. [7M]

UNIT-IV

7 a) What are the various available methods to improve the engine performance? [7M]

b) Enumerate the following parameters that effect the performance of an S.I. engine: [7M]
(i) Compression ratio,
(ii) Air-fuel ratio,
(iii)Engine speed,
(iv)Mass of indicated charge,
(v) Heat losses.

Or

8 a) What are the various methos used to measure the indicated power? Enumerate. [7M]

b) A single cylinder, four-stroke gas engine has a bore of 200 mm and a stroke of 330 mm and is governed on the hit and mass principle. When running at 500 rpm at full load, indicator card are taken which given a working loop mean effective pressure of 8 bar and pumping loop mean effective pressure of 0.5 bar. Diagrams from the dead cycle given a mean effective pressure of 0.7 bar. When running at no load a mechanical counter recorded 60 firings strokes per minute. Calculate at full load with regular firing, brake power and mechanical efficiency of the engine. [7M]

UNIT-V

9 a) The pressure ratio of an open cycle gas turbine power plant is 5.7. Air is taken at 27^oC and 1 bar. The compression is carried out in two stages with perfect intercooling in between. The maximum temperature of the cycle is limited 850^oC. Assuming the isentropic efficiency of each compressor as 80% and that of turbine as 87%, determine the power developed and efficiency of the power plant, if the air flow is 1.8 kg/s. The mass of fuel may be neglected, and it may be assumed that C_p = 1.08 kJ/kg K and $\gamma = 1.41$. [7M]

b) What is a rocket engine? Explain the principle and working of a rocket engine. [7M]

Or

10 a) What is a ram-jet engine? Explain various parts of a ram-jet engine with neat diagram. [M]

b) In a gas turbine plant air at 11^oC and 1 bar is compressed through a pressure ratio of 5:1. In a heat exchanger and combustion chamber the air is heated to 800^oC while its pressure drops 0.14 bar. After expansion through the turbine the air passes through a heat exchanger which cools the air through 70% of the maximum range possible, while the pressure drops 0.15 bar, and the air is finally exhausted to atmosphere. The isentropic efficiency of both compressor and turbine is 0.85. Calculate the efficiency of the plant . [8M]

Code No: R2022033 **R20** **SET - 2**

II B. Tech II Semester Regular/Supplementary Examinations, July - 2023

THERMAL ENGINEERING-I

(Mechanical Engineering)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks
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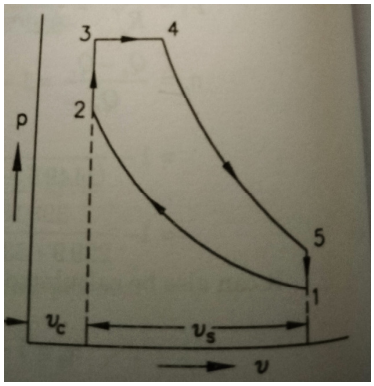
UNIT-I

1 a) Draw $p-V$ and $T-s$ diagram of otto cycle. Derive the expression for thermal efficiency, work output and mean effective pressure of otto cycle. [8M]

b) Compare actual and air-standard cycles of a gasoline engine. [6M]

Or

2 a) The compression ratio for a single cylinder engine operating on dual cycle is 8. The maximum pressure in the cycle is limited to 48 bar. The pressure and the temperature of the air at the starting of the cycle are 1 bar and 27°C. Heat is added during constant pressure process upto 4% of the stroke. Assuming the cylinder diameter as 20 cm and stroke as 30 cm, find the following: [7M]
(i) The work per cycle,
(ii) The air-standard efficiency of the cycle,
(iii) The power developed if number of working cycles are 200 per minute.
Assume all the processes are ideal.



b) Explain the following in detail: [7M]
(i) Time loss factor
(ii) Loss due to gas exchange process

UNIT-II

3 a) Explain the following liquid cooling systems in I.C. engines: [7M]
(i) Thermo-syphon cooling,
(ii) Forced-pump cooling.

b) Draw and explain the battery ignition system that is employed in spark ignition system. [7M]

Or

4 a) What are the different kinds of fuels used in I.C. engines. [7M]
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b) Explain the following carburetors with neat sketch; [7M]
(i) Zenith carburetor,
(ii) S.U. carburetor

UNIT-III

5 a) Draw and explain various combustion chambers of S.I. engines. [7M]

b) what is delay period? Enumerate various factors that affect the delay period in C.I. engines. [7M]

Or

6 a) Explain the concept of pre-ignition. Explain the causes of pre-ignition. What are the tests conducted for pre-ignition. [7M]

b) Discuss various direct combustion chambers and also pre-ignition chambers that are used in C.I. engines. [7M]

UNIT-IV

7 a) Enumerate various I.C. engine emissions and discuss the causes of emissions. [7M]

b) Develop an expression for the calculation of indicated mean effective pressure, indicated power, brake power, brake mean effective pressure. [7M]

Or

8 a) Explain the principle and working of Prony and Rope brake dynamometers that are used for brake power measurement. [8M]

b) Following data refers to a four stroke double acting diesel engine having cylinder diameter 250 mm and piston stroke 400 mm. [6M]
m.e.p. on cover side = 7 bar
m.e.p. on crank side = 7.5 bar
speed= 400 rpm.
diameter of piston rod = 22 mm
dead load on the brake = 1200 N
spring balance reading = 140 N
brake wheel diameter = 1.5 m
brake rope diameter = 22 mm
Calculate the mechanical efficiency of the engine.

UNIT-V

9 a) What is a gas turbine? Give detailed explanation of classification of gas turbines [4M]

b) A turbo-jet engine flying at a speed of 1000 km/h consumes air at a rate of 55 kg/s. Calculate: [10M]
   (i) Exit velocity of jet when the enthalpy change for the nozzle is 150 kJ/kg and velocity co-efficient is 0.98.
   (ii) Fuel flow rate in kg/s when the air-fuel ratio is 65:1
   (iii) Thrust specific fuel consumption
   (iv) Thermal efficiency of the plant when the combustion efficiency is 90% and calorific value is 42000 kJ/kg
   (v) Propulsive power
   (vi) Propulsive efficiency

Or

10 a) A gas turbine unit has a pressure ratio of 6:1 and maximum cycle temperature of 875 K. The isentropic efficiency of the compressor and the turbine are 0.80 and 0.82 respectively. Calculate the power output in kilowatts of an electric generator geared to the turbine when the air enters the compressor at 15^{o}C at the rate of 18kg/s. Take c_p = 1.005 kJ/kgK and γ = 1.4 for the compression process and take c_p = 1.11 kJ/kg K and γ = 1.333 for the expansion process. [7M]

b) Draw and explain the turbo-jet engine with neat sketch. [7M]

Code No: R2022033 **R20** **SET - 3**

II B. Tech II Semester Regular/Supplementary Examinations, July - 2023

THERMAL ENGINEERING-I

(Mechanical Engineering)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) Derive the air-standard efficiency, work ratio for maximum work and work ratio for Brayton cycle or Joule cycle with the help of $p - V$ and $T - s$ diagram. [8M]

b) Discuss the effect of spark advance on the performance of otto cycle engine. What is meant by optimum spark advance. [6M]

Or

2 a) A diesel engine working on a dual combustion cycle has a stroke volume of 0.0088 m^3 and a compression ratio 15:1. The fuel has a calorific value of 43800 kJ/kg. At the end of the suction, the air is at 1 bar and 95°C. The maximum pressure in the cycle is 60 bar and air fuel ratio is 19:1. Find for ideal cycle the thermal efficiency. Assume c_p = 1.0 and c_v = 0.70. [8M]

b) How does the composition of exhaust gases vary for various fuel-air ratios in a gasoline engine? [6M]

UNIT-II

3 a) Draw and explain the Magneto-ignition system that is employed in spark ignition system. [7M]

b) What are the main functions of an injection pump? Explain the two injection pumps that are commonly used. [7M]

Or

4 a) What is a carburetor? What are the essential components of a carburetor? Explain each of the component in detail. [7M]

b) How are S.I. and C.I. engines are rated? [7M]

UNIT-III

5 a) Discuss the important qualities that are required for the fuel for C.I. engines. [7M]

b) What is turbocharging? How the process of turbo charging is carried out in I.C. engines. [7M]

Or

6 a) what are the objectives that need to be fulfilled to design a combustion chamber in S.I. engines ? [7M]

b) Explain the phenomenon of knocking. Compare knocking inS.I. and C.I. engines. [7M]

UNIT-IV

7 a) Explain NDIR method for carbon dioxide measurement techniques. [6M]

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b) What are the variables that effect the performance curves. [8M]

Or

8 a) Draw and explain volumetric type fuel flowmeter. [7M]

b) The following particulars were obtained in a trail on a 4-stroke gas engine: [7M]
Duration of trail = 1 hour; Revolutions = 12000; Number of missed cycles = 400;
Net brake load = 1400 N; Mean effective pressure = 8 bar;
Gas consumption = 20000 litres; L.C.V. of gas at supply condition = 20 kJ/litre;
Cylinder diameter = 250 mm;Stroke = 400 mm; Effective brake circumference = 4m
Compression ratio = 65:1; Calculate :
(i) Indicated power, (ii) Brake power, (iii) Mechanical efficiency, (iv) Indicated thermal efficiency, (v) Relative efficiency

UNIT-V

9 a) Air is drawn in a gas turbine unit at 20°C and 1.01 bar and pressure ratio is 6:1. The compressor is driven by the H.P. turbine and L.P. turbine drives a separate power shaft. The isentropic efficiencies of compressor and H.P. and L.P. turbines are 0.80 and 0.85 and 0.82 respectively. If the maximum cycle temperature is 700°C. Calculate: [8M]
(i) The pressure and temperature of the gases entering the power turbine,
(ii) The net power developed by the unit per kg/s mass flow.
(iii)The work ratio
(iv)The thermal efficiency
Neglect mass of the fuel and assume the following:
For compression process :C_{pa} = 1.005 kJ/kg K and γ = 1.4
For combustion and expansion processes:C_{pg} = 1.15 kJ/kg K and γ = 1.333.

b) What is turbo jet engine? Describe each part of turbo jet engine in detail. Write its advantages and disadvantages. [6M]

Or

10 a) What is a turbo propeller engine? Explain various parts of a turbo propeller engine with neat diagram. [5M]

b) In a gas turbine plant, air is compresses through a pressure ratio of 5:1 form 19°C. It is then heated to maximum permissible temperature of 820°C and expanded in two stages each of expansion ratio $\sqrt{7}$. The air being reheated between the stages to 820°C. A heat exchanger allows heating of the compressed gases through 75% of the maximum possible range. Calculate : [9M]
(i) The cycle efficiency,
(ii) Work ratio,
(iii)The work per kg of air,
The isentropic efficiencies of turbine and compressor are 0.85 and 0.89 respectively.

Code No: R2022033 **R20** **SET - 4**

II B. Tech II Semester Regular/Supplementary Examinations, July - 2023
THERMAL ENGINEERING-I
(Mechanical Engineering)

Time: 3 hours **Max. Marks: 70**

Answer any **FIVE** Questions each Question from each unit
All Questions carry **Equal** Marks
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UNIT-I

1 a) Draw $p-V$ and $T-s$ diagram of diesel cycle. Derive the expression for thermal efficiency, work output and mean effective pressure of diesel cycle. [8M]

b) Explain how the volumetric efficiency effect the performance of the engine? Also list out the factors that effect the volumetric efficiency. [6M]

Or

2 a) In a gas turbine power plant working on Brayton cycle, the air at inlet is 27^{o}C, 0.12 MP_a. the pressure ratio is 6 and the maximum temperature is 1000K. The turbine and compressor efficiencies are 85% each. Find compressor work, turbine work, heat supplied, cycle efficiency and turbine exhaust temperature. Mass of the air is 1 kg. draw its *T-s* diagram. [7M]

b) Explain the following in detail: [7M]
(i) Heat loss factor
(ii) Spark advance

UNIT-II

3 a) Explain the Thermostat liquid cooling systems in I.C. engines. [8M]

b) Draw and explain the wet sump lubrication system. [6M]

Or

4 a) What is a Solex carburetor? Explain the principle and working of a solex carburetor with a neat sketch. [7M]

b) Explain the electronic diesel fuel injection system in detail. [7M]

UNIT-III

5 a) Define flame speed? Enumerate the Influence factors that affect the flame speed. [7M]

b) Explain with figures various types of combustion chambers that are employed in C.I. engines. [7M]

Or

6 a) Explain the effect of various engine variables on knocking in S.I. engines. [7M]

b) Enumerate the different stages of combustion in C.I. engines. [7M]

UNIT-IV

7 a) Classify meters used for air flow measurement and explain in detail. [7M]
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b) The following observations were recorded in a test of one hour duration on a single-cylinder oil engine working on four stroke cycle. [7M]
Bore = 400 mm; Stroke = 550 mm; Fuel used = 8 kg;
Calorific value of fuel = 41800 kJ/kg; Average speed = 300 rpm; m.e.p. = 6 bar;
Brake friction load = 1900 N; Quantity of cooling water = 650 kg;
Temperature rise = 20^{o}C; Diameter of the brake wheel = 1.44 m;
Calculate (i) Mechanical efficiency (ii)Brake thermal efficiency.
Draw the heat balance sheet.

Or

8 a) Explain the following methods that estimate the friction power: [7M]
(i) Willian's line method
(ii) Morse test.

b) Draw the engine performance curves and explain in detail. [7M]

UNIT-V

9 a) A gas turbine unit has a pressure ratio of 5:1 and maximum cycle temperature of 945 K. The isentropic efficiency of the compressor and the turbine are 0.85 and 0.80 respectively. Calculate the power output in kilowatts of an electric generator geared to the turbine when the air enters the compressor at 12^{o}C at the rate of 22kg/s. Take c_p = 1.005 kJ/kg K and γ = 1.4 for the compression process and take c_p = 1.11 kJ/kg K and γ = 1.333 for the expansion process. [7M]

b) Discuss briefly various methods to improve the thermal efficiency of an open cycle gas turbine power plant. [7M]

Or

10 a) Explain various gas turbine fuels in detail also write their suitable examples. [6M]

b) A turbo jet has a speed of 800 km/h while flying at an altitude of 10000 m. The propulsive efficiency of the jet is 50% and overall efficiency of the turbine plant is 18%. The density of air at 10000 m altitude is 0.186 kg/m. The drag on the plant is 6000N. the calorific value of the fuel is 48000 kJ/kg. Calculate : [8M]
(i) Absolute velocity of the jet
(ii) Volume of air compressed per minute
(iii)Diameter of the jet
(iv)Power output of the unit in kW
(v) Air-fuel ratio