QUESTION BANK

ME8493 – THERMAL ENGINEERING

UNIT I –GAS AND STEAM POWER CYCLES

PART-A

1. Write any four differences between Otto and Diesel cycle?

- Otto cycle consist of Two isentropic and two constant volume processes Diesel cycle consist of two adiabatic, one constant volume and one constant pressure processes
- Heat addition takes place in constant volume process Heat addition takes place in constant pressure process
- Efficiency is more than diesel cycle for the same compression ratio Efficiency is less than Otto cycle for the same compression ratio
- Compression ratio is equal to expansion ratio Compression ratio is greater than expansion ratio

2. Define mean effective pressure as applied to gas power cycles.

Mean effective pressure is defined as the constant pressure acting on the piston during the working stroke. It is also defined as the ratio of work done to the stroke volume of piston displacement volume.

3. Compare the Diesel and Brayton cycles

Diesel cycle

1. It consist of two isentropic, one constant
2. Heat is rejected at constant volume
3. Used in Diesel engines

Brayton cycles

1. It consist of two isentropic, one constant volume and one constant pressure processes pressure processes
2. Heat is rejected at constant pressure
3. Used in gas turbines

4. Why Brayton cycle is used in gas turbine?

Inside the turbine the gas is continuously flowing in the processes are flow processes. Since all the processes involved in Brayton cycle is flow process, it has been used as the cycle for gas turbine.

5. Define mean effective pressure.

It is defined as the average pressure acting on the piston during the entire power stroke that would produce the same amount of net work output during the actual cycle. It is also defined as the ratio of work-done per cycle to swept volume.

6. **What is a thermodynamic cycle?**

Thermodynamic cycle is defined as the series of processes performed on the system, so that the system attains its original state.

7. **What are the assumptions made for air standard cycle analysis?**

(i)The working medium is a perfect gas throught i.e., It follows the law **pv = mRT**

(ii)The working medium does not undergo any chemical change throughout The Cycle.

(iii)The compression and expansion processes are reversible adiabatic i.e., There is no loss or gain of entropy.

(iv)The operation of the engine is frictionless.

8. **Mention the various processes of dual cycle.**

(i) Isentropic compression.

(ii) Constant pressure heat supplied.

(iii) Isentropic expansion, and

(iv) Constant pressure heat rejection.

9. **Define air standard cycle efficiency.**

Air standard efficiency is defined as the ratio of work done by the cycle to heat supplied to the cycle.

10. **Define mean effective pressure as applied to gas power cycles.**

Mean effective pressure is defined as the constant pressure acting on the piston during the working stroking. It is also defined as the ratio of work done to the stroke volume or piston displacement volume.

11. **Define the following terms (i) Compression ratio (ii) Cut off ratio and (iii) Expansion ratio?**

(i) Compression ratio is defined as the ratio between total cylinder volumes to clearance volume.

(ii) Cut off ratio is defined as the ratio of volume after the heat addition to volume before the heat addition.

(iii) Expansion ratio is the ratio of volume after the expansion to the volume before expansion.

12. **What is the effect cut-off ratio on the efficiency of diesel cycle when the compression ratio is kept constant?**

When cut-off ratio of diesel cycle increases, the efficiency of cycle is decreased when compression ratio is kept constant and vice versa.

QUESTION BANK

ME8493 – THERMAL ENGINEERING

UNIT II – RECIPROCATING AIR COMPRESSOR

PART-A

1. Classify the various types of air compressors.

   1) According to the and principle of operation

      a)Reciprocating compressors

      b) Rotary compressors.

   2) According to the action

      a) Single acting compressors

      b) Double acting compressors

   3) According to the number of stages

      a) Single stage compressors

      b) Multistage compressors

   4) According to the pressure limit

      a)Low pressure compressors

      b)Medium pressure compressors

      c) High pressure compressors

   5) According to the capacity

      a)Low capacity compressors

      b) Medium capacity compressors

      c) High capacity compressors

2. What is meant by single acting compressors?

   In single acting reciprocating compressor, the suction, compression and delivery of air takes place on both sides of the piston

3. What is meant by single stage compressor?

   In single stage compressor, the compression of air from the initial pressure to the final .pressure is carried out in one cylinder only.

4. What is meant by double acting compressor?

   In double acting reciprocating compressor, the suction, compression and delivery of air takes place on both sides of the piston.

5. Indicate the application of reciprocating compressors in industry?

   The applications of compressed air as follows:

   1) Pneumatic brakes
   2) Pneumatic jakes.
   3) Pneumatic drills.
   4) Pneumatic lifts.
   5) Spray painting.
   6) Shop cleaning.
   7) Injecting fuel in diesel engines.
   8) Supercharging internal combustion engines.
   9) Refrigeration, and air conditioning systems.

6. What are the advantages of multi stage compression with internal cooling over single stage compression for the same pressure ratio?

   1. It improves the volumetric efficiency for the given pressure ratio.
   2. It reduces the leakage loss considerably.
   3. It gives more uniform torque and hence a smaller size flywheel is required.
   4. It reduces the cost of the compressor.

7. Define the terms as applied to air compressors: Volumetric efficiency and isothermal compression efficiency.

   (or)

   Define the mechanical efficiency and isothermal efficiency of a reciprocating air compressor.

   Volumetric efficiency:

   Volumetric efficiency is defined as the ratio of volume of free air sucked into the compressor per cycle to the stroke volume of the cylinder.

   Volumetric efficiency: Volume of free air taken per cycle/Stroke volume of the cylinder.

   Isothermal compression efficiency:

Isothermal efficiency is defined as the ratio between isothermal work to the actual work of the compressor.

$$\text{Isothermal efficiency} = \frac{\text{brake power}}{\text{Indicated power}}$$

8. Define clearance ratio?

Clearance ratio is defined as the ratio of clearance volume to swept volume (or) stroke volume.

$$C = \frac{Vc}{Vs}$$

Vc=Clearance volume Vs=Swept volume

9. Discuss the effect of clearance upon the performance of an air compressor.

The volumetric efficiency of air compressor increases with decrease in clearance of the compressor.

10. Give two merits of rotary compressor over reciprocating compressor.

1. Rotary compressor gives uniform delivery of air where compared to reciprocating compressor.
2. Rotary compressors are small in size for the same discharge as compared with reciprocating compressors.
3. Lubricating system is more complicated in reciprocating compressor where as it is very simple in rotary compressor.

11. Name the methods adopted for increasing isothermal efficiency of reciprocating air compressor.

Isothermal efficiency is increased by perfect inter cooling.

12. Why clearance is necessary and what is its effect on the performance of reciprocating compressor?

When the piston reaches top dead center in the cylinder, there is a dead space between piston top and cylinder head. This space is known as clearance space and the volume occupied by this space is known as clearance volume.

13. What is meant by inter cooler?

    An inter cooler is a simple heat exchanger. It exchanges the heat of compressed air from the low-pressure compressor to the circulating.

14. What are the factors that affect the volumetric efficiency of a reciprocating compressor?

    1. Clearance volume.
    2. Compression ratio.

15. What is compression ratio?

    Compression ratio is defined as the ratio between total volume and clearance volume.

$$\text{Compression ratio} = \frac{\text{Total volume.}}{\text{Clearance volume.}}$$

QUESTION BANK

ME8493 – THERMAL ENGINEERING

UNIT III – INTERNAL COMBUSTION ENGINES AND COMBUSTION

PART-A

1. List the various components of engine.

(i)Cylinder block

(ii)Cylinder head

(iii)Crankcase

(iv) Cylinder liners

(v) Piston& piston rings

2. Name the basic thermodynamic cycles of the two types of internal combustion reciprocating engines.

Otto cycle in S.I engines and diesel cycle in C.I engines.

3. Define compression ratio of an IC engine?

It is the ratio of volume when the piston is at BDC to the volume when the piston is at TDC.

4. Define the terms Mean effective pressure?

It is defined as the algebraic sum of the mean pressure acting on the during one complete cycle.

5. What is meant by highest useful compression ratio?

The compression ratio which gives maximum efficiency is known as highest useful compression ratio.

6. Why compression ratio of petrol engines is low while diesel engines have high compression ratio?

Since fire point of petrol is less as compared to diesel, petrol engine has low compression ratio.

7. Compare the thermal efficiency of petrol engines with diesel engines. Give reasons.

Thermal efficiency of diesel engine is greater than petrol engine this is due to high compression ratio.

8. What do you mean by scavenging in I.C. Engines?

The process of removing the burnt gases from the combustion chamber of engine cylinder by using fresh air fuel mixture is known as Scavenging.

9. Define Cetane number?

The property that quantities the ignition delay is called as Cetane number.

10. Which is better efficient two stroke or four stroke engines?

Two-stroke engine give always lesser efficiency than four-stroke engine due to incomplete combustion and poor scavenging.

11. Why a choke is used in carburetor and what is meant by automatic chocking?

Initially, more fuel is required to reduce high starting torque which is done by using supply unit will be cut off by a choke called automatic choking.

12. What are the important requirements of fuel injection system?

* The beginning as well as end of injection should take place sharply
* Inject the fuel at correct time in the cycle throughout the speed range of the engine.
* The injection of fuel should occur at the correct rate and in correct quantity as required by the varying engine load.
* Atomize the fuel to the required degree.
* Distribute the fuel throughout the combustion chamber for better mixing.

13. Mention different types of fuel injection systems in C. I engines.

a) Air injection system

b) Airless or Solid injection

(i) Common rail system

(ii) Individual pump system.

14. Define delay period with respect to a CI engine.

The physical delay period is the time between the beginning of injection and the attainment of chemical reaction reaction conditions. During this period fuel is atomized, mixed with air and raised to its self-ignition temperature.

15. What is the purpose of providing spark plug in SI engine?

The function of a spark plug is to produce an electric spark for the ignition of compressed air-fuel mixture inside the engine cylinder.

16. What is the purpose of a thermostat in an engine cooling system?

A Thermostat valve is used in the water-cooling system to regulate the circulation of water in system to maintain the normal working temperature of the engine parts during the different operating conditions.

17. State any three functions of lubrication?

a) It reduces friction between moving parts.

b) It reduces wear and tear of the moving parts. c) It minimizes power boss due to friction.

QUESTION BANK

ME8493 – THERMAL ENGINEERING

UNIT IV – INTERNAL COMBUSTION ENGINE PERFORMANCE AND SYSTEMS

PART-A

1. List the various components of engine.

   (i)Cylinder block

   (ii)Cylinder head

   (iii)Crankcase

   (iv) Cylinder liners

   (v) Piston& piston rings

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    * The injection of fuel should occur at the correct rate and in correct quantity as required by the varying engine load.

    * Atomize the fuel to the required degree.

    * Distribute the fuel throughout the combustion chamber for better mixing.

13. Mention different types of fuel injection systems in C. I engines.

a) Air injection system

b) Airless or Solid injection

(i) Common rail system

(ii) Individual pump system.

14. Define delay period with respect to a CI engine.

The physical delay period is the time between the beginning of injection and the attainment of chemical reaction reaction conditions. During this period fuel is atomized, mixed with air and raised to its self-ignition temperature. During the chemical delay reactions start slowly ad then accelerate until ignition takes place.

15. What is the purpose of providing spark plug in SI engine?

The function of a spark plug is to produce an electric spark for the ignition of compressed air-fuel mixture inside the engine cylinder.

16. What is the purpose of a thermostat in an engine cooling system?

A Thermostat valve is used in the water-cooling system to regulate the circulation of water in system to maintain the normal working temperature of the engine parts during the different operating conditions.

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QUESTION BANK

ME8493 – THERMAL ENGINEERING

UNIT V – GAS TURBINES

PART-A

1. When the reheater is employed in the gas turbine cycle?

   When air fuel ratio is high, the combustion products after expansion in the high pressure turbine contain more oxygen. This can be utilised in the reheater and the gas is further expanded in the low-pressure turbine.

2. Define isentropic efficiency of turbine and compressor in a Joule cycle.

   $\eta_{turbine}$ = Actual internal work / Work of isentropic expansion

   $\eta_{compressor}$ = Work of isentropic compression / Actual internal work

3. Why Brayton cycle is used in gas turbine?

   Inside the turbine the gas is continuously flowing in the processes are flow processes. Since all the processes involved in Brayton cycle is flow process, it has been used as the cycle for gas turbine.

4. What is a Gas turbine? How do you classify.

   Gas turbine is an axial flow rotary turbine in which working medium is gas.

   Classification of gas turbine

   1. According to the cycle of operation
      - a. Open cycle
      - b. Closed cycle and
      - c. Semi – closed cycle.
   2. According to the process
      - a. Constant volume and
      - b. Constant pressure process.

5. What is meant by open cycle gas turbine?

   In open cycle gas turbine, the exhaust gas form turbine is exhausted to the atmosphere and fresh air is taken in compressor for every cycle.

6. Differentiate open and closed cycle gas turbines.

Open cycle gas turbine Closed cycle gas turbine

1. Working substance is exhausted to the atmosphere after one cycle. 1. The same working substance is re circulated again and again.

2. Pre-cooler is not required 2. Pre-cooler is required to cool the exhaust gas to the original temperature.

3. High quality fuels are used 3. Low quality fuels are used

4. For the same power developed size and weight of the plant is small 4. Size and weight are bigger.

7. Why re-heater is necessary in gas turbine? What are its effects?

The expansion process is very often performed in two separate turbine stages. The re-heater is placed between the H.P. and L.P. turbines to increase the enthalpy of the exhaust gas coming from H.P. turbine.

Effects:

- Turbine output is increased for the same compression ratio
- Thermal efficiency is less.

8. What is the function of regenerator in gas turbine?

The main function of heat regenerator is to exchange the heat from exhaust gas to the compressed air for preheating before combustion chamber. It increases fuel economy and increase thermal efficiency.

SVS COLLEGE OF ENGINEERING

Department of Mechanical Engineering

QUESTION BANK

ME8493 – THERMAL ENGINEERING

PART - B

UNIT I –GAS AND STEAM POWER CYCLES

1. A Dual combustion air standard cycle has a compression ratio of 10. The constant pressure part of combustion takes place at 40 bar. The highest and the lowest temperature of the cycle are 1725degree C and 27 0 C respectively. The pressure at the beginning of compression is 1 bar. Calculate (I) the pressure and temperature at' key points of the cycle. (ii) The heat supplied at constant volume, (iii) the heat supplied at constant pressure. (iv) The heat rejected. (v) the work output. (vi) the efficiency and (vii) mep.
2. An Engine-working on Otto cycle has a volume of 0.45 m3 , pressure 1 bar and temperature 30o,Cat the beginning of compression stroke. At the end of compression stroke, the pressure is 11 barand 210 KJ of heat is added at constant volume. Determine (i) Pressure, temperature and volumes at salient points in the cycle. (ii) Efficiency.
3. Air enters the compressor of a gas turbine at 100 KPa and 25 o C. For a pressure ratio of 5 anda maximum temperature of 850°C. Determine the thermal efficiency using the Brayton cycle. The following data in referred for an air standard diesel cycle compression ratio = 15 heat added= 200 Kj/Kg- minimum temperature in the cycle = 25°C Suction pressure = 1 bar Calculate i) Pressure and temperature at the Salient point. ii)Thermal efficiency iii) Mean effective pressure iv) Power output of the cycle If flow rate of air is 2Kg/s
4. A refrigeration system of 10.5 tonnes capacity at an evaporator temperature of -12°C and a condenser temperature of 27°C is needed in a food storage locker. The refrigerant Ammonia is sub cooled by 6°C before entering the expansion valve. The compression in the compressor is of adiabatic type. Find 1. Condition of vapor at outlet of the compressor.2. Condition of vapor at the entrance of the Evaporator 3.COP &power required.

5. Air enters the compressor of a gas turbine at 100 KPa and 25 o C. For a pressure ratio of 5 and a maximum temperature of 850°C. Determine the thermal efficiency using the Brayton cycle
6. A diesel engine operating an air standard diesel cycle has 20cm bore and 30cmstroke.the clearance volume is 420cm3.if the fuel is injected at 5% of the stroke,find the air standard efficiency
7. The compression ratio of an air standard dual cycle is 12 and the maximum pressure on the cycle is limited to 70bar. The pressure and temperature of the cycle at the beginning of compression process are 1bar and 300K. Calculate the thermal efficiency and Mean Effective Pressure. Assume cylinder bore = 250mm, Stroke length = 300mm, Cp=1.005KJ/Kg K, Cv=0.718KJ/Kg K.
8. Estimate the lose in air standard efficiency for the diesel engine for the compression ratio 14 and the cutoff changes from 6% to 13% of the stroke.
9. In an Otto cycle air at 1bar and 290K is compressed isentropic ally until the pressure is 15bar The heat is added at constant volume until the pressure rises to 40bar. Calculate the air standard efficiency and mean effective pressure for the cycle. Take Cv=0.717 KJ/Kg K and Runiv = 8.314KJ/Kg K.
10. Define Brayton Cycle with Derivation for Air Standard Cycle & Mean Effective Pressure.
11. Define Dual Cycle with Derivation for Air Standard Cycle & Mean Effective Pressure.
12. Define Diesel Cycle with Derivation for Air Standard Cycle & Mean Effective Pressure.
13. Define Otto Cycle with Derivation for Air Standard Cycle & Mean Effective Pressure.

UNIT II - RECIPROCATING AIR COMPRESSOR

1. A single stage single acting air compressor is used to compress air from 1 bar and 22° C to 6 bar according to the law PV1 .25 = C. The compressor runs at 125 rpm and the ratio of stroke length to bore of a cylinder is 1.5. If the power required by the compressor is 20 kW, determine the size of the cylinder.
2. A single stage single acting air compressor is used to compress air from 1.013 bar and 25° C to 7 bar according to law PV 1.3 = C. The bore and stroke of a cylinder are 120mm and 150mm respectively. The compressor runs at 250 rpm .If clearance volume of the cylinder is 5% of stroke volume and the mechanical efficiency of the compressor is 85%, determine volumetric efficiency, power, and mass of air delivered per minute.
3. A two stage singe acting air compressor compresses 2m3 airs from 1 bar and 20° C to 15 bar. The air from the low pressure compressor is cooled to 25° C in the intercooler. Calculate the minimum power required to run the compressor if the compression follows PV1.25=C and the compressor runs at 400rpm.
4. A two stages, single acting air compressor compresses air to 20bar. The air enters the L.P cylinder at 1bar and 27oc and leaves it at 4.7bar. The air enters the H.P. cylinder at 4.5bar and 27oc. the size of the L.P cylinder is 400mm diameter and 500mm stroke. The clearance volume In both cylinder is 4% of the respective stroke volume. The compressor runs at 200rpm, taking index of compression and expansion in the two cylinders as 1.3, estimate 1. The indicated power required to run the compressor; and 2. The heat rejected in the intercooler per minute.
5. A two stage singe acting air compressor compresses 2m3 airs from 1 bar and 20° C to 15 bar. The air from the low pressure compressor is cooled to 25° C in the intercooler. Calculate the minimum power required to run the compressor if the compression follows PV1.25=C and the compressor runs at 400 rpm.
6. A single stage single acting air compressor is used to compress air from 1.013 bar and 25° C to 7 bar according to law PV 1.3 = C.The bore and stroke of a cylinder are 120mm and 150mm respectively. The compressor runs at 250 rpm .If clearance volume of the cylinder is 5% of stroke volume and the mechanical efficiency of the compressor is 85%, determine volumetric efficiency, power, and mass of air delivered per minute.

UNIT III - INTERNAL COMBUSTION ENGINES AND COMBUSTION

1. The following results refer to a test on a petrol engine Indicated power = 30 Kw, Brake power = 26 Kw. Engine speed = 1000 rpm Fuel brake power/ hour = 0.35 kg Calorific value of fuel = 43900kj/kg Calculate The indicated Thermal efficiency, The brake Thermal efficiency, The Mechanical efficiency
2. A four cylinder 2 stroke cycle petrol engine develops 23.5 kw brake power at 2500 rpm. The mean effective pressure on each piston in 8. 5 bar and mechanical efficiency in 85% Calculate the diameter and stroke of each cylinder assuming the length of stroke equal to 1.5 times the diameter of cylinder.
3. The following data to a particular twin cylinder two stroke diesel engine. Bore 15 cm stroke. 20 cm. speed 400 rpm. Indicated mean effective pressure 4 bar, dead weight on the brake drum 650 N. spring balance reading 25 N Diameter of the brake drum 1 m .Fuel consumption 0.075 kg/min and calorific value of the fuel is 44500 kJ/kg. Determine i) Indicated Power ii) Brake Power iii) Mechanical efficiency iv) Indicated thermal efficiency v)Brake thermal efficiency.
4. The following observations are recorded during a test on a fourstroke petrol engine, F.C = 3000 of fuel in 12sec, speed of the engine is 2500rpm, B.P = 20KW, Air intake orifice diameter = 35mm,Pressure across the orifice = 140mm of water coefficient of discharge of orifice = 0.6, piston diameter = 150mm, stroke length = 100mm, Density of the fuel = 0.85gm/cc , r=6.5, Cv of fuel = 42000KJ/Kg, Barometric pressure = 760mm of Hg , Room temperature = 24oc

UNIT IV INTERNAL COMBUSTION ENGINE PERFORMANCE AND SYSTEMS

1. Compare two stroke and four stroke engine
2. Mention the various methods of lubrication system and explain any two in detail.
3. Explain why cooling is necessary in IC engine? With neat sketches describe the working of water cooling system used for a multi cylinder engine. Why should a pump and thermostat be provided in the cooling system of an engine?
4. Compare petrol and diesel engine.
5. Explain the construction and working of fuel injector.
6. Explain the working of mechanical fuel pump with a neat sketch.
7. Explain the working of magneto ignition system and compare its merits and demerits with battery ignition system.
8. Explain the working of 4-stroke petrol engine.
9. Sketch the typical valve timing diagram of a high speed 4-stroke petrol engine
10. Explain any one lubrication system adopted in multi cylinder SI engines
11. Explain the different types of cooling systems with neat sketches.
12. What are the common defects that are found in cooling system and give their rectification?
13. Explain the components of fuel injection system for diesel engines.
14. What are methods of fuel injection available for diesel engines. Explain them in detail with neat sketches.

UNIT V GAS TURBINES

1. An ideal Brayton-cycle gas turbine with regeneration but no reheat or intercooling operates at full load with an inlet temperature to the compressor of 60 ^{o}F and an inlet temperature to the turbine of 1540 ^{o}F. The cycle is also to be operated at part load at a pressure ratio of 3.0 with a turbine inlet temperature of 1100 ^{o}F. Compare the thermal efficiency and net work output per lbm flow for the two operating points if the working fluid (air) is treated as a perfect gas and the maximum possible regeneration is obtained.
2. Air enters the compressor of a gas turbine at 100 KPa and 25 o C. For a pressure ratio of 5 and a maximum temperature of 850°C. Determine the thermal efficiency using the Brayton cycle.
3. Drive the expression for air standard efficiency of Brayton cycle in terms of pressure ratio.