**AALIM MUHAMMED SALEGH COLLEGE OF ENGINEERING**

**DEPARTMENT OF MECHANICAL ENGINEERING**

**QUESTION BANK**

**DEPARTMENT: MECH SEMESTER: V**

**SUBJECT CODE / Name: ME 2301 / THERMAL ENGINEERING**

**PART-A**

**UNIT – I GAS POWER CYCLES**

**1. Define air standard efficiency.**

When the engine is working with air as the medium, then the efficiency of the engine is said to be air standard efficiency.

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| **2. Define relative efficiency.** |  |

Relative efficiency is the ratio between actual thermal efficiency and air standard efficiency.



**3. What are the assumptions made in analysis of air standard cycle?**

1. There is no chemical reaction taking place when the heat is supplied or rejected.
2. The physical constants of the gas in the cylinder are the same as that of air at moderate temperature.
3. The processes like compression and expansion are adiabatic and they are frictionless.
4. The gas used in the process is a perfect gas. (obeys gas laws).

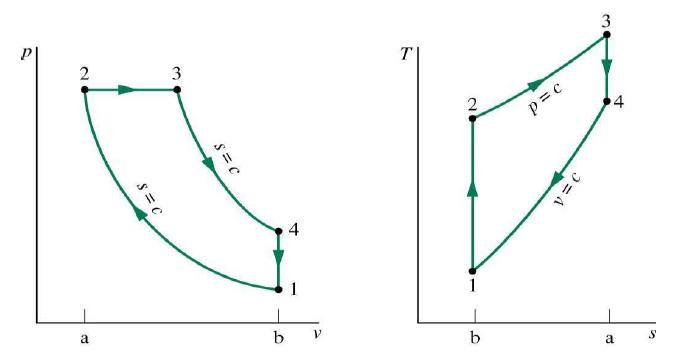
**4.Which air standard cycle (Otto/ Diesel/ Dual) is more efficient for the same heat input? Justify.**

Among Otto, Diesel and Dual combustion cycles, there is least heat rejection in Otto cycle. Hence Otto cycle has more efficiency.

**5. List out the important factors which are used for comparison of Diesel, Otto and Dual cycles.**

1. Compression ratio.
2. Maximum pressure
3. Heat supplied
4. Heat rejected
5. Net work done.

**6. Sketch the P-v and Ts diagram of Diesel cycle.**

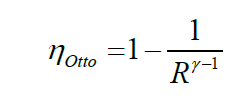
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| **7. Define mean effective pressure of Otto cycle.** |  |

Mean effective pressure is defined as the constant pressure acting on the piston during the working stroke. It is the ratio between workdone and stroke volume.

**8. How does the change in compression ratio affect the air standard efficiency of an ideal Otto cycle?**

The expression for the air standard efficiency of an Otto cycle is given by,



R – Compression ratio

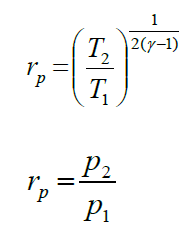
γ – Ratio of specific heats

From the above expression the efficiency increases with the increase in the value of R compression ratio, which means that the efficiency could be improved, by increasing the compression ratio. But increasing the compression ratio also has a considerable extent due to practical difficulties.

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| **9. Mention four thermodynamic processes involved in diesel cycle.** |  |

1. Isentropic compression
2. Constant pressure heat addition
3. Isentropic expansion
4. Constant volume heat rejection

**10. Give the expression for pressure ratio for maximum work in Brayton cycle.**



**UNIT – II INTERNAL COMBUSTION ENGINES**

**1. What is the function of camshaft and crank shaft?**

Camshaft converts the rotary motion of cam into linear motion of the follower. It operates the inlet and outlet valves through rocker arm.

Crank shaft converts the reciprocating motion of the piston into rotary motion.

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| **2. List out the effects of detonation.** |  |

1. Noise and roughness
2. Mechanical damage to the engine parts
3. Carbon deposit on cylinder walls
4. More heat transfer
5. Reduced efficiency and power.

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| **3. Define nozzle efficiency.** |  |

Nozzle efficiency is the ratio of actual enthalpy drop to the isentropic enthalpy drop.



**4. What is the function of push rod and rocker arm?**

The motion of the cam is transmitted to the valve through the push rod and rocker arm. These links combinedly known as valve gear.

**5. What are the basic requirements of a fuel injection system of a diesel engine.**

1. Constant supply of fuel from cycle to cycle operation
2. Uniform and constant supply of fuel from cylinder to cylinder
3. Atomize the fuel to the required level
4. Beginning of injection at proper timing

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| **6. What is the effect of friction on the flow through a steam nozzle?** |  |

1. The expansion is no more isentropic and enthalpy drop is reduced thereby resulting in exit velocity.
2. The final dryness fraction of steam will be increased.
3. The specific volume of steam will be increased.

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| **7. What is splash lubrication?** |  |

Splash lubrication is applicable in small sized internal combustion engines. In this system, the oil from the sump is splashed to the moving parts of the engine with spool. A small hole is drilled in the crank shaft and the oil is forced through this hole to the bearings.

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| **8. What do you mean by supersaturated flow?** |  |

The steam may not have time to condense and remains dry, when the expansion through the nozzle is very rapid. This type of flow is called supersaturated flow.

**9. What is the importance of delay period in CI engine combustion phenomena?**

If the delay period is more, more diesel fuel will be injected in the combustion chamber and pressure rise will be more. This leads to diesel knock.

But delay period is needed to disperse and atomize the fuel in the air for complete combustion. Hence an optimum and required time should be given for the delay period depending on the combustion characteristics of the engine.

**10. How CI combustion chambers of diesel engine classified?**

1. Non turbulent type – Open combustion engine
2. Turbulent type – (a) Turbulent chamber (b) Pre-combustion chamber (iii) Energy cell

**UNIT III – STEAM NOZZLES AND TURBINES**

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| **1. What is critical pressure ratio of a steam nozzle?** |  |

Critical pressure is the ratio of the outlet pressure to inlet pressure only when the mass flow per unit area is maximum.

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| **2. What is the need for compounding in steam turbines?** |  |

In a simple impulse turbine, if the steam is expanded from the boiler pressure to condenser pressure in one stage the speed of the rotor becomes tremendously high which crops up practical complicacies. There are few methods of reducing the speed to the lower value, all these methods utilize a multiple system of rotor in series keyboard to a common shaft. This is known as compounding.

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| **3. Give the working principle of an impulse turbine.** |  |

The operation of impulse turbine depends on the dynamic action of steam expanding through nozzle. The enthalpy of steam is first converted into kinetic energy in nozzle. The high velocity of steam impinges on the curved blade fixed on the circumference of rotor. The rotor charges to the flow direction of steam which causes the force to be exerted on the rotor.

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| **4. What is blading efficiency?** |  |

Blading efficiency is also known as diagram efficiency. It is defined as the ratio of work done on the blade to the energy supplied to the blade.

**5. What is the effect of friction on the flow through a steam nozzle?**

1. The expansion process will not be isentropic and enthalpy drop will get reduced, which further lead to reduced exit velocity.
2. The final dryness fraction will increase.
3. The specific volume of the steam will increase.

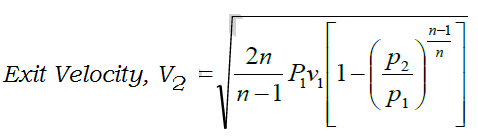
**6. What is the function of governor in steam turbine?**

The governor in the steam turbine maintains a constant rotor speed, even during the varying load condition.

**7. What is the effect of superheating in Rankine cycle?**

The effect of superheating increases the mean temperature of heat addition and hence the cycle efficiency.

**8. What is the expression for exit velocity of steam where the flow is said to be supersaturated?**



**9. Explain supersaturated flow (or) Meta stable flow in steam nozzles.**

When the superheated steam is expanded in the nozzle the condensation should occur in the nozzle. Since the steam has a great velocity, the condensation does not take place at the expected rate. So the equilibrium between the liquid and vapour phase is delayed and the steam continues to expand in a dry state. The flow of steam expanding like this is called supersaturated flow or meta stable flow.

**10. What is Wilson line?**

The limiting condition of under cooling at which condensation commences and is assumed to restore conditions of normal thermal equilibrium is called “*Wilson line*”.

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| **11. State the necessity of governing of steam turbine.** |  |

Governing is to maintain the speed of the turbine fairly constant at varying load conditions.

**UNIT IV – AIR COMPRESSORS**

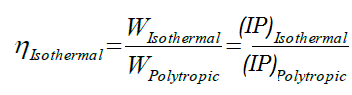
**1. How is air compressors classified?**

Air compressors are classified into,

1. Reciprocating compressor and rotary compressor.
2. Single stage and multistage compressor.
3. Single acting and double acting compressor.

**2. Define isothermal efficiency of air compressors.**

It is defined as the ratio of isothermal work to polytropic work.



**3. What is meant by FAD (*Free Air Delivery*)?**

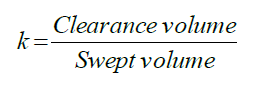
Free air delivered is defined as the actual volume ratio of air reduced to atmospheric condition and usually expressed in *m3/min*.

**4. What is meant by perfect inter-cooling?**

If the temperature of air leaving the intercooler is equal to the original inlet temperature the inter-cooling is known as perfect inter-cooling. By having inter-cooling, we can approach the isothermal process. So the isothermal efficiency will be increased by perfect inter-cooling.

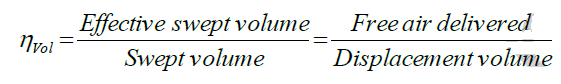
**5. Define clearance ratio of an air compressor.**

The ratio between clearance volume to swept volume is called clearance ratio (k).



**6. Define volumetric efficiency of an air compressor.**

Volumetric efficiency of an air compressor is the ratio of free air delivered to the displacement of the compressor.



**7. Explain the working principle of rotary compressor.**

In rotary compressor the air is entrapped between two sets of engaging surfaces and the pressure either by back flow of air (roots blower) or by both squeezing action and backflow of air (vane type).

**8. What are the various methods to improve the isothermal efficiency?**

The various methods for improving the isothermal efficiency are,

1. Spray injection
2. Water jacketing
3. Inter-cooling
4. External fins

**9. Which type of compression is the best one in reciprocating compressor? State the reason.**

Isothermal compression is the best one in reciprocating compressor as it requires less power to drive the compressor.

**10. What factors limit the delivery pressure in a reciprocating compressor?**

1. The size of the cylinder will be too large for very high pressure.
2. Due to compression, there will be a rise in the temperature of the air. So the delivery pressure is limited, so that rise in temperature of air is not going beyond limit and size of cylinder is not too large.

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| **11. What is the effect of clearance upon the performance of air compressor?** |  |

1. It is necessary to avoid the piston hitting the cylinder end.
2. For the movement of valves, a space to be left when the piston travel upwards. Hence clearance volume is provided.
3. The maximum compression pressure is also controlled by clearance volume.

**12. What are the advantages of multistage compression with intercooling over single stage compression for the same pressure ratio?**

1. The workdone per kg of air is reduced in multistage compression with intercooler when compared with single stage compression for the same delivery pressure.
2. There will be increase in volumetric efficiency also.

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| **13. Classify the various types of air compressors.** |  |

Air compressors are basically classified into positive displacement air compressors and dynamic air compressors.

Positive displacement air compressors are further classified into

1. Reciprocating air compressor
2. Rotory
   1. Roots blower (b) Screw type (c) Vane type

Dynamic air compressors are further classified into

(i) Centrifugal air compressor (ii) Axial flow air compressor.

**14. State the effect of clearance on work done in a reciprocating compressor.**

1. Actual suction volume decreases
2. Mass of air is reduced
3. Volumetric efficiency decreases

**UNIT V- REFRIGERATION AND AIR CONDITIONING**

**1. What is commonly used unit of refrigeration?**

The “Ton of Refrigeratio” is the commonly used unit for refrigeration. It is defined as the quantity of heat required to extract the heat from 1000 kg of water at 0o C into 1000 kg of ice at 0o C within 24 hours.

1 Ton of refrigeration ≈ 3.5 kW

**2. Distinguish between summer air conditioning and winter air cnditioning.**

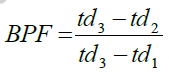
In summer air conditioning the air gains both sensible and latent heat. Hence the conditioning of air is done by both cooling and dehumidification. In winter air conditioning, heating and humidification is done to the air.

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| **3. Define RSHF line.** |  |

It is Room Sensible Heat Factor (RSHF) line. This line is drawn parallel to the base line in the psychrometric chart.

**4. Define by pass factor of a heating coil.**

The ratio of the difference between the mean surface temperature of the coil and leaving air temperature to the difference between the mean temperature and the entering air temperature is known as by pass factor.



**5. What is the effect of sub cooling a refrigerant in a vapour compression cycle?**

1. Refrigerating effect is increased
2. COP of the plant is increased.
3. Liquid refrigerant below the condensing temperature.

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| **6. What is dew point temperature?** |  |

It is the temperature of air when the water vapour present, begins to condense. It is measured by thermometer.

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| **7. Define the COP of refrigeration.** |  |

The coefficient of performance is the ratio of heat extracted in the refrigerator to the work done on the refrigerant.

**8. What is the basic difference between vapour compression and vapour absorption refrigeration system?**

In vapour compression system a compressor is used, hence it is noisy. In vapour absorption system compressor is not used, hence it is noiseless.

Vapour absorption differs from vapour compression system with a principle that, it uses heat energy instead of mechanical energy.

**9. Define relative humidity and wet bulb temperature.**

Relative humidity is the ratio of mass of water vapour in the air in a given volume at a given temperature to the mass of water vapour contained in the same volume at same temperature when the air is saturated.

Wet bulb temperature, is the quantity of temperature measured by the thermometer when the bulb of the thermometer is wrapped with a wet cloth.

**10. Differentiate between heat pump and refrigerator.**

Heat pump takes the atmospheric air and supplies the heat to the air and the heat is rejected to the space to be warmed.

Refrigerator extracts the heat from the space to be cooled and heat is given out to the atmosphere.

**PART-B**

**UNIT I -- GAS POWER CYCLES**

1. Drive and expression for the air standard efficiency of Otto cycle in terms of volume ratio.

2. Drive an expression for the air standard efficiency of Diesel cycle.

3. Drive an expression for the air standard efficiency of Dual cycle.

4. Explain the working of 4 stroke cycle Diesel engine. Draw the theoretical and actual PV diagram.

5. Drive the expression for air standard efficiency of Brayton cycle in terms of pressure ratio.

6. 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.

7. An Engine-working on Otto cycle has a volume of 0.45 m3, pressure 1 bar and temperature 30 0C at the beginning of compression stroke. At the end of compression stroke, the pressure is 11 bar and 210 KJ of heat is added at constant volume. Determine (i) Pressure, temperature and volumes at salient points in the cycle.' (ii) Efficiency.

8. (I) Explain the working of 4-stroke cycle Diesel engine. Draw the theoretical and actual valve- timing diagram for the engine. Explain the reasons for the difference.

9. (II) 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

1. Pressure and temperature at the Salient point.
2. Thermal efficiency
3. Mean effective pressure,
4. Power output of the cycle If flow rate 'of air is 2 Kg/s.

**UNIT II - INTERNAL COMBUSTION ENGINES**

1. Explain full pressure lubrication system I.C Engine.

2. Explain the water cooling system in I.C Engine.

3. Explain the 2 types of Ignition system In 5.1 Engine.

4. Draw and explain the valve timing diagram of 4 stroke Diesel Engine.

5. Draw and explain the port timing diagram of 2stroke Petrol Engine.

6. Explain with neat sketch the exhaust gas analysis.

7. 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 (i) The indicated Thermal efficiency (ii) The Brake Thermal efficiency & (iii) The Mechanical efficiency

8. 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.

9. 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/J kg. Determine

1. Indicated Power
2. Brake Power
3. Mechanical efficiency
4. Indicated thermal efficiency
5. Brake thermal efficiency

**UNIT III – STEAM NOZZLES AND TURBINES**

1. An impulse turbine having a set of 16 nozzles receives steam at 20 bar, 400° C. The pressure of steam at exist is 12 bar. If the total discharge Is 260 Kg/min and nozzle efficiency is 90%. Find the cross sectional area of each nozzle, if the steam has velocity of 80m/s at entry to the nozzle, find the percentage Increase In discharge.

2. Dry saturated steam at a pressure of 8 bar enters the convergent divergent nozzle and leaves it at a pressure 1.5 bar. If the flow isentropic and if the corresponding index of expansion is 1.133, find the ratio of 0.3 are at exit and throat for max. discharge.

3. Steam enters a group of nozzles of a steam turbine at 12 bar and 2200 C and leaves at 1.2 bar. The steam turbine develops 220 Kw with a specific steam consumption of 13.5 Kg/ Kw. Hr. If the diameter of nozzle at throat Is 7mm . Calculate the number of nozzle 4. Drive an expression for critical pressure ratio in terms of the index of expansion 5. Explain the method of governing in steam turbine.

6. Explain various type of compounding in Turbine

7. A 50% reaction turbine running at 400 rpm has the exit angle of blades as 20° and the velocity of steam relative to the blade at the exit is 1.35 times mean speed of the blade. The steam flow rate is 8.33 kg/s and at a particular stage the specific volume is 1.38m3/kg .Calculate, suitable blade height, assuming the rotor mean diameter 12 times the blade height, and diagram work.

8. The blade angle of a single ring of an impulse turbine is 300m/s and the nozzle angle is 200.Theisentropic heat drop is 473kJ/kg and nozzle efficiency is 85%.Given the blade velocity coefficient is 0.7and the blades are symmetrical, Draw the velocity diagram and calculate for a mass flow of 1 kg/s i) axial thrust on balding ii) steam consumption per BP hour if the mechanical efficiency is 90% iii) blade efficiency and stage efficiency.

**UNIT IV – AIR COMPRESSORS**

1. Drive an expression for the work done by single stage single acting reciprocating air compressor.

2. Drive an expression for the volumetric efficiency of reciprocating air compressors

3. Explain the construction and working of a root blower.

4. Explain the construction and working of a centrifugal compressor.

5. Explain the construction and working of a sliding vane compressor and axial flow compressor.

6. 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.

7. 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.

8. 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.

**UNIT V- REFRIGERATION AND AIR CONDITIONING**

1. Draw neat sketch of simple vapor compression refrigeration system and explain.

2. Explain with sketch the working principle of aqua Ammonia refrigeration system.

3. Explain with sketch the working principle of water-Lithium bromide refrigeration system.

4. Briefly explain the cooling load calculation in air conditioning system.

5. Explain winter, summer, and year round Alc system.

6. Explain unitary Alc and central Alc system.

7. Explain any four psychometric processes with sketch.

8. 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.

9. A sling psychrometer in a lab test recorded the following readings DBT=35°C, WBT=25°C

Calculate the following

1. Specific humidity
2. Relative humidity
3. Vapor density in air
4. Dew point temperature
5. Enthalpy of mixing per kg of air .take atmospheric pressure=1.0132 bar.