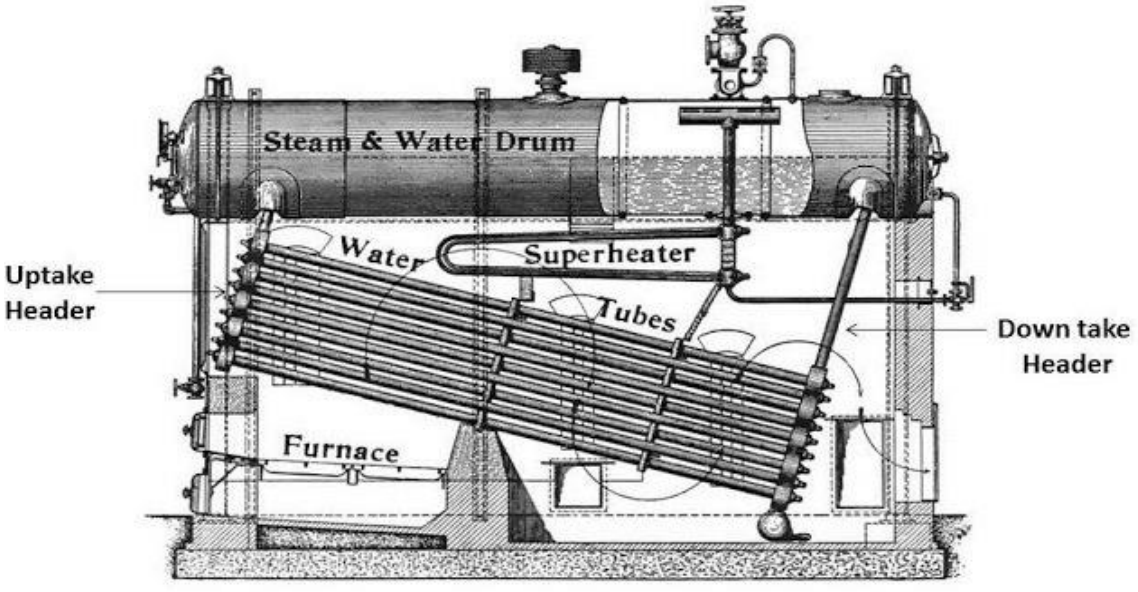
WINTER – 19 EXAMINATION

Subject Name: Basic Mechanical Engineering **Model Answer** Subject Code: 22214

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N	Answer	Marking Scheme
Q.1	a)	Any Five (2x5) Enthalpy a property of a thermodynamic system, is equal to the system's internal energy plus the product of its pressure and volume. The unit of measurement for enthalpy in (SI) is the joule.	2M Definition-1 Unit-1
	b)	Following are the applications of nozzle 1. Steam and gas turbine 2. Jet engines 3. Rocket motors 4. Flow Measurement-in Venturimeter	Any four ½ M each
	c)	Parts of centrifugal pump are 1. An impeller 2. A volute or diffuser style casing 3. A shaft 4. Shaft sleeves 5. Bearings 6. A sealing arrangement	Any four ½ M each
	d)	Causes for engine do not start in cold are 1. Gasoline, like any other liquid, evaporates less when it is cold. 2. Oil gets a lot thicker in cold weather.	Any two 1M each

		3. Batteries have problems in cold weather	
	e)	One ton of refrigeration: A ton is of refrigeration is defined as "the quantity of heat required to remove from one ton of ice within 24 hours when initial condition of water is 0 ^{0}c ", because the same cooling effect will be given by melting the same ice.	2M
	f)	Component of domestic refrigerator are 1. Compressor 2. Condenser 3. Expansion device (Capillary tube) 4. Evaporator 5. Accumulator 6. Thermostat	Any four ½ M each
	g)	Pressure is defined as the physical force exerted on an object. The force applied is perpendicular to the surface of objects per unit area. or Pressure is the force applied over a unit area. The basic formula for pressure is F/A (Force per unit area). Unit of pressure is Pascals (Pa) N/m^2	1M 1M
Q.2	a)	 Babcock and Wilcox Boiler **Function of main Parts (Any three)** 1. Steam separator drum: This drum is situated upside of the boiler. It is larger diameter drum in which water and	1M 1M each

steam placed together. The one half of the drum is filled with water and the other half is remaining for steam.

2. Water tubes:

Water tubes are situated bottom side of the drum. Water flows from the drum to the tubes.

3. Uptake header:

Steam separator drum and water tubes are connected by the two tubes. One is known as uptake header and the other one is known as down take header. The steam from the water tubes to the drum flow by the uptake header.

4. Down take header:

The water flows from the drum to the water tubes through down take header. When the steam flows by uptake header to the drum, at the same time water flows from drum to the water tubes by down take header which maintains the flow of water.

5. Grate:

The place in the furnace, where the fuel is placed and burn known as grate.

6. Furnace:

The furnace is the place where the fuel burns. This is situated at the down side of the water tubes. When the fuel burns, the flue gases generate. This gases flow upper side and passes through water tube, which heat the water and convert it into steam.

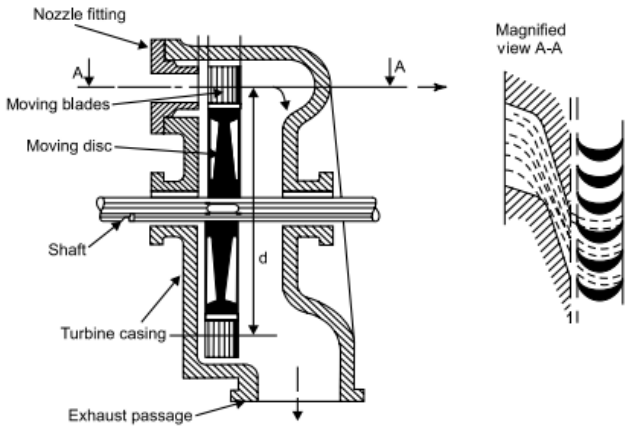
7. Super heater:

Super heater is situated upper side of the water tube. One end of super heater is connected to the drum and other end is for process work. Steam flows from the drum to the super heater, where it heated by the flue gases and send for the process work.

8. Baffles:

Baffles are provided between the water tubes. The main function of baffles is to divert the flue gases, so it flows more than one time through the tube and more heat is transfer.

b)



Schematic of simple impulse steam turbine stage

Fig 2M

Function of Component (Any Two)

1M each

1. Nozzle:

Nozzles are used to guide the steam to hit the moving blades and to convert the pressure energy into the kinetic energy.

2. *Turbine Blades*
   The impulse blades must be designed to convert the kinetic energy of the steam into mechanical energy.
3. *Turbine Seals*
   Seals are used to reduce the leakage of steam between the rotary and stationary parts of the steam turbine.
4. *Turbine Casings*
   The turbine casings are heavy in order to withstand the high pressures and temperatures.
5. Shaft Seals
   Shaft seals are used to prevent the steam leakage where the shafts extend through the casing.

c)

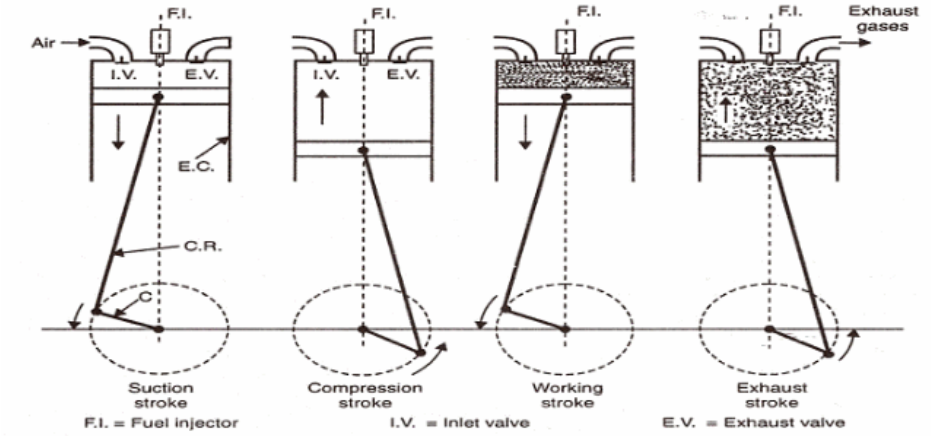


Fig. 2M

Compression ignition (CI) engines operate generally on "Diesel"/"Dual" cycle. In these engines the combustion is realized due to excessive compression and is so called compression ignition engines. Here air alone is sucked inside the cylinder during suction stoke and compressed. Degree of compression is much more than that of spark ignition (SI) engines. After compression of air the fuel is injected into the high pressure and high temperature compressed air. Due to high temperature of air the combustion of fuel gets set on its' own. Self ignition of fuel takes place due to temperature of air-fuel mixture being higher than self ignition temperature of fuel. Thus in CI engines, larger amount of compression causes high temperature, therefore unassisted combustion.

Working 2M

Stroke 1*:* Piston travels from TDC to BDC and air is sucked.

Stroke 2*:* Piston travels from BDC to TDC, while air is compressed with inlet and exit passages closed.

Stroke 3*:* Piston reaches TDC and air gets compressed. Fuel injector injects fuel into compressed air for certain duration. Ignition of fuel also takes place simultaneously as air temperature is much higher than self ignition temperature of fuel. Burning of fuel results in release of fuel chemical energy, which forces piston to travel from TDC to BDC. Contrary to SI engine where heat addition gets completed near

instantaneously, in CI engines fuel injection and thus heat addition is spread in certain stroke travel of piston i.e. heat addition takes place at constant pressure during which piston travels certain stroke length as decided by cut-off ratio. This is expansion process and piston comes down to BDC with both inlet and exit valves closed.

Stroke 4*:* After expansion piston reverses its motion upon reaching BDC and travels up to TDC with exit passage open. During this piston travel burnt gases are expelled out of cylinder i.e. exhaust stroke. Completion of above four strokes requires two revolutions of crankshaft.

d) Pollutants in a steam power plant- — 2M

1. Carbon dioxide
2. Sulfur dioxide
3. Nitrogen oxides
4. Ash
    - The ash, and the constituents contained within, can also leach into water systems that are used for human consumption, and this can make the local water unpotable for the surrounding community.
    - Whilst the release of certain pollutants affects the flora and fauna within the localized environment,
    - From a global perspective, many greenhouse gases are now released into the atmosphere and have become a major man-made contributor of climate change and global warming.
    - When the water in a power plant is no longer usable, it often gets discharged into a local waterway that affects the local environment.

2M

Q.3

Any Three (3x4)

a) 1.High fuel consumption in I.C. engine (Any Two) — 2M

Reason	Remedy
Faulty Engine	Adjust carburetor, replace worn out spark plug , air cleaner Maintenance of throttle valve, oxygen sensor
Poor Engine oil	Replace engine oil
Poor quality fuel	Replace fuel
Worn out tyers	Replace tyers
Wrong gears	Change driving style
Poor Maintenance	Do timely maintenance

2. Overheating of I.C. engine(Any Two) — 2M

Reason	Remedy
Leaks in cooling system	Do the maintenance of cooling system
Coolant Concentration	Use the correct type of coolant

Bad Thermostat	Replace thermostat
Bad Radiator	Replace radiator
Bad Radiator Fan	Replace fan
Loose water pump/ fan belt	Replace belt
Bad Water pump	Replace water pump

b) Gas turbine engines derive their power from burning fuel in a combustion chamber and using the fast flowing combustion gases to drive a turbine in much the same way as the high pressure steam drives a steam turbine. A simple gas turbine is comprised of three main sections a compressor, a combustor, and a power turbine. The gas-turbine operates on the principle of the Brayton cycle, where compressed air is mixed with fuel, and burned under constant pressure conditions. The resulting hot gas is allowed to expand through a turbine to perform work. — 2M

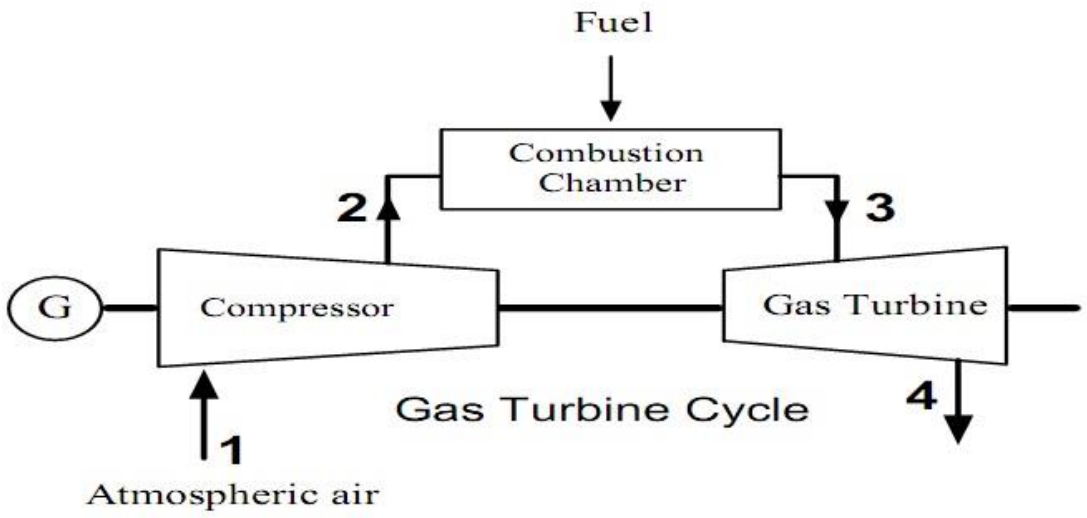
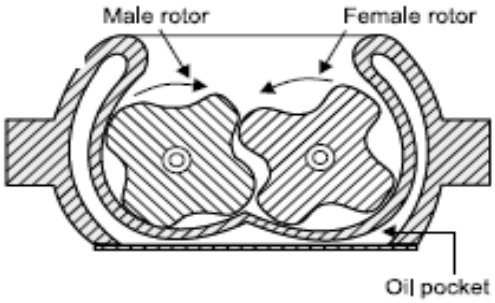


Fig.-2M

c)

Basis of comparison	Open cycle gas turbine	Close cycle gas turbine
Components	Main components are compressor, combustion chamber and turbine	Main components are compressor, combustion chamber, turbine and cooling chamber.
Working	Simple in working and less costly Here the compressed air is heated in the combustion chamber.	Complex in working and costly. The air is heated by external source in a heating chamber

2M each

	d)	Applications of submersible pump are 1. drainage, 2. slurry pumping 3. sewage pumping 4. water wells 5. oil wells 6. seawater handling 7. fire fighting 8. deep well drilling 9. irrigation 10. mine dewatering 11. artificial lifts 12. offshore drilling rigs.	Any Four 4M
Q.4	a)	 Screw type compressor ***Screw type compressor:*** Screw type compressor is very much similar to roots blower. These may have two spiral lobed rotors, out of which one may be called male rotor having3–4 lobes and other female rotor having 4–6 lobes which intermesh with small clearance. Meshing is such that lobes jutting out of male rotor get placed in matching hollow portion in female rotors. Initially, before this intermeshing the hollows remain filled with gaseous fluid at inlet port. As rotation begins the surface in contact move parallel to the axis of rotors toward the outlet end gradually compressing the fluid till the trapped volume reaches up to outlet port for getting discharged out at designed pressure. Since the number of lobes is different so the rotors operate at different speed. Two rotors are brought into synchronization by the screw gears. Thrust upon rotors is taken care of by oil lubricated thrust bearings. These compressors are capable of handling gas flows ranging from 200 to 20000 m^3/h under discharge pressures of 3 bar in single stage and up to 13 bar in two stages. Even with increase in number of stages pressures up to 100 bar absolute have been obtained with stage pressure ratio of 2. Mechanical efficiency of these compressors is quite high and their isothermal efficiencies are even more than vane blowers and may be compared with centrifugal and axial compressors. But these are very noisy, sensitive to dust and fragile due to small clearances.	2M 2M
	b)	**Methods to reduce power consumption of air compressor** 1. Cooling cylinder by spraying water during compression stroke. 2. Circulation of water surrounding to cylinder by providing jackets 3. Installing inter cooler between two cylinders	4M

		4. Providing greater fins on cylinder 5. By selecting suitable material for cylinder 6. By providing suitable choice of cylinder proportions i.e. short stroke and large bore in construction with sleeve valve	
	c)	Given data: Heat supplied = 19.50 kW , Brake power = 4.2 kW Brake thermal efficiency = Brake power / Heat supplied = 4.2 / 19.50 =0.2154 = 21.54 %	4M
	d)	Given data: Water head (H) = 130 m , Discharge (Q) = 3.5 m3/s, density (ω) = 9.81 kN/m3 Power developed by the turbine = ωQH = 9.810x103x3.5x130 = 4463550 W = 4463.550 kW	 1M 1M 1M 1M
	e)	**Classification of Air compressors**: 1. According to principle: a) Reciprocating air compressors b) Rotary air compressors 2. According to the capacity a. Low capacity air compressors b. Medium capacity air compressors c. High capacity air compressors 3. According to pressure limits a. Low pressure air compressors b. Medium pressure air compressors c. High pressure air compressors 4. According to method of connection a. Direct drive air compressors b. Belt drive air compressors	4M 01 M each
Q.5	a)	**Any Two (2x6)** **Air conditioning systems are classified as** **1) Classification as to major function-** i) Comfort air-conditioning - air conditioning in hotels, homes, offices etc. ii) Commercial air-conditioning- air conditioning for malls, super market etc ii) Industrial air-conditioning – air conditioning for processing, laboratories etc.	02 M

		2) Classification as to season of the year- i) Summer air-conditioning - These system control all the four atmospheric conditions for summer comfort. ii) Winter air-conditioning – This system is designed for comfort in winter. iii) Year round air-conditioning – These system consists of heating and cooling equipments with automatic control to produce comfortable condition throughout the year **3) Classification as to Equipment Arrangement-** i) Unitary system ii) Central system *Explanation of any one air conditioning system with sketch – explain any one system with fig.* *(Note- If students explain any system other than this it may be consider.)*	02 M for fig. 02 M for explanation
	b)	**Suitable type of A/c for:** i) Computer Lab with 60 PCs: Split A/c in Multiple numbers (may be 6 to 8 A/c of 1Ton capacity required) As 1 Ton capacity A/c cools approx. 100 sq. feet ii) A room of 5m x 5m - Split A/c of 2 Ton capacity As 1 Ton capacity A/c cools approx. 100 sq. feet ii) A city Bus of 45 people capacity – Unitary system 1 unit of 7 to 8 Tons with duct system As bus is used for transportation, looses are more. Ducts are required above each seat for proper distribution of cooled air.	2M Each

c) Compressor does not work — 6M

Sr. No.	Cause	Remedy
1.	Refrigerator fan stops	Replace fan
2.	Faulty electric supply	Check / repair the electrical supply
3.	Valves of compressor choked due liquid entry or valves not operating	Check / repair compressor valves
4.	Faulty start relay	Replace start relay
5.	Compressor motor not working or coil burned	Check / repair compressor motor
6.	Faulty thermostat	Check / repair thermostat

1M each

Q.6 **Any Two (2x6)**

a) **Vapour Compression Refrigeration Cycle (2 Marks)** — 2M

Beginning the cycle at the evaporator inlet, the low pressure liquid absorbs heat, and evaporates, changing to a low pressure vapour at the evaporator outlet. The compressor pumps this vapour from the evaporator, increases its pressure, and discharges the high pressure vapour to the condenser. In the condenser, heat is removed from the vapour as it condenses and becomes a high pressure liquid. Between the condenser and the evaporator, an expansion device is located.

The flow of refrigerant into the evaporator is controlled by the pressure differential across the expansion device. As the high pressure liquid refrigerant enters the evaporator, it is subjected to a much lower pressure due to the suction of the compressor and the pressure drop across the expansion device. The refrigerant tends to expand and evaporate. In order to evaporate, the liquid must absorb heat from the air passing over the evaporator, and the cycle is repeated.

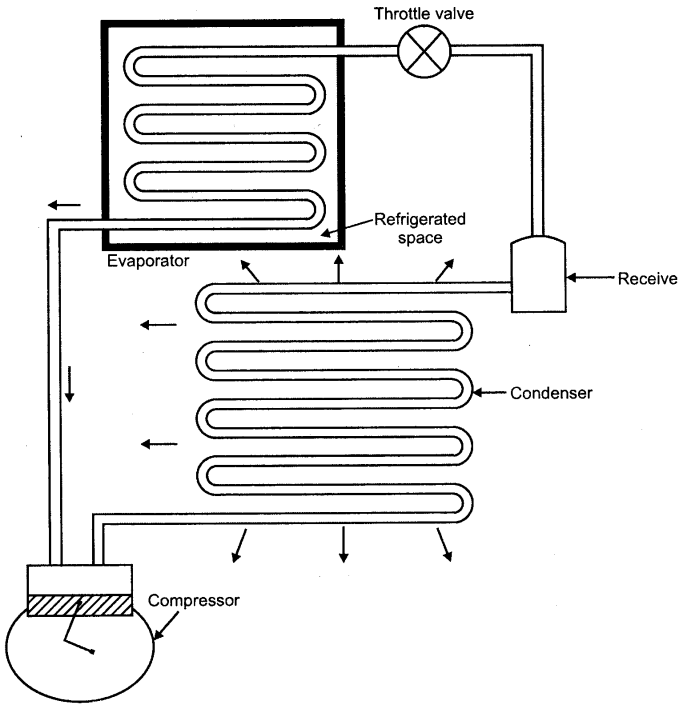


Fig. 2M

		The main components of VCC are: **(Any two component)** 1) Compressor: Compressor is the most important component of VCC refrigeration system and is considered being the heart of the system. The function of compressor is to compress the low pressure refrigerant from evaporator to condenser pressure at a temperature more than saturation temperature corresponding to condenser pressure. 2) Condenser: condenser is heat rejection component in vapour compression system. Function of condenser in refrigeration system is to superheat and condense the compressor discharged vapour and frequently to sub-cool the liquid with minimum pressure drop. 3) Expansion Device: It is the pressure reducing component in vapour compression system. Its function is to reduce pressure of refrigerant from condenser pressure to evaporator pressure by throttling and to control mass flow rate of refrigerant entering in evaporator as per load on evaporator. 4) Evaporator: It is a component in which refrigerating effect is obtained. Refrigerating effect is produced in evaporator. The liquid at low pressure enters in evaporator, by absorbing heat it converts into vapours. These vapours are drawn in suction line of compressor.	2M 01 M each
	b)	Requirements of boiler mountings: For efficient operation and maintenance of safety, the boiler equipped with two categories of components and elements. First categories include the fittings which are primarily indicated for the safety of the boiler and for complete control the process of steam generation. These units are called mountings. The mounting from an integral part of the boiler and are mounted on the body of the boiler itself. The following mountings are usually installed on the boiler.(Any four) 1. Two safety valve 2. Two water level indicators 3. Pressure gauge 4. Fusible plug 5. Steam stop valve 6. Feed check valve 7. Blow-of cock 8. Man and mud hole Second categories include the components which are installed to increase the efficiency of the steam power plants and help in the power working of the boiler unit. These fitting are called boiler accessories. The accessories are given below.(Any four) 1. Air pre-heater 2. Economizer	1M 2 M 1M 2M

3. Super heater

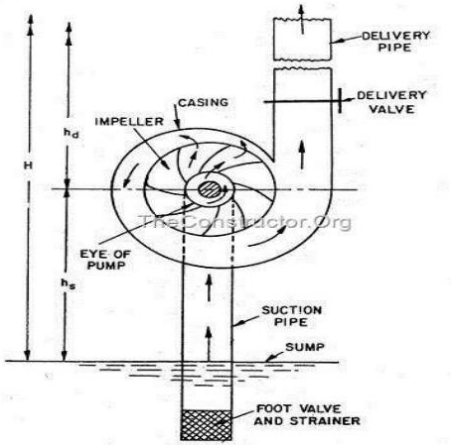
4. Feed pump and

5. Injector

c)

Sr.No	Reciprocating Pump	Rotary Pump
1	Displacement by reciprocation of piston	Displacement by rotary action of gear, cam or vanes
2	Flow is pulsating	Flow is smooth
3	It requires more space	It requires less space
4	It requires higher maintenance	It requires lower maintenance
5	Higher initial cost	Lower initial cost
6	It is for high pressure applications	It is for low/medium pressure applications
7	It is suitable for high viscosity fluids	It has optimum performance with high viscosity fluids

Any 4 points 1M each



2M