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Scheme of evaluation Internal Assessment Test - I – March. 2017

Sub:	Elements of Mechanical Engineering						**Code:**	15EME24
Date:	28 /03 / 2017	Duration:	90 mins	Max Marks:	50	**Sem:** 1	**Section:**	**ALL**

PART – A: [Answer any 4 questions]

1. a) Define:
(i) Brake Power (ii) Thermal Efficiency (iii) Ice Making Capacity
(iv) Ton of Refrigeration **[04 x 1 = 04]**

b) With simple sketch explain the following lathe operations
(i) Facing (ii) Knurling

2. With a neat sketch explain vapour absorption refrigeration system. **[10]**

3. Explain the construction and working of a 2 stroke petrol engine with the help of neat sketches. Draw its PV diagram. **[10]**

4. With the help of a neat sketch explain the working of a 4 stroke compression ignition engine. Also

5. Differentiate between (a) petrol and diesel engine, and
(b) 2 stroke and 4 stroke engine. **[5 x 2 = 10]**

6. With a neat sketch explain window type air conditioning process. **[10]**

PART – B: [Answer any 1 question]

7. The following observations were made during a trial run of a single cylinder 4 – stroke cycle oil engine: stroke = 300mm, bore = 200mm, piston speed = 3.5m/s, torque = 630Nm, mechanical efficiency = 30%, indicated thermal efficiency = 30% and calorific value of the fuel=43,900kJ/kg. Calculate the mean effective pressure and mass of fuel consumed per hour. [**10]**

8. A single cylinder 4 – stroke engine has a swept volume of 4.5litres. The mean effective pressure is 0.65MPa and the engine speed is 505rpm. If there are 250 explosions per minute and the brake torque is 176Nm, find indicated power and brake power of the engine. **[10]**

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1. a) Define:
   (i) Brake Power (ii) Thermal Efficiency (iii) Ice Making Capacity
   (iv) Ton of Refrigeration **[04 x 1 = 04]**

   b) With simple sketch explain the following lathe operations
   (i) Facing (ii) Knurling

Ans: Each sketch – 1.5 M
Explanation of each operation – 1.5 M

2. With a neat sketch explain vapour absorption refrigeration system. **[10]**

Ans: Sketch – 4M
Explanation – 6M

3. Explain the construction and working of a 2 stroke petrol engine with the help of neat sketches. Draw its PV diagram. **[10]**

Ans: Sketch of the 2 stroke petrol engine – 2M
Construction explanation – 2M
Working – 4M
P-V Diagram – 2M

4. With the help of a neat sketch explain the working of a 4 stroke compression ignition engine. Also draw its PV diagram. **[10]**

Ans: Sketch of the 4 stroke compression ignition engine – 4M
Working – 4M
P-V Diagram – 2M

5. Differentiate between (a) petrol and diesel engine, and
   (b) 2 stroke and 4 stroke engine. **[5 x 2 = 10]**

Ans: Each sub-part constitutes 5 marks. A minimum of five differences should be listed in each part.
Difference: 5 x 2 = 10M

6. With a neat sketch explain window type air conditioning process. **[10]**

Ans: Sketch – 4M

Explanation – 6M

<u>PART – B</u>: [Answer any 1 question]

7. The following observations were made during a trial run of a single cylinder 4 – stroke cycle oil engine: stroke = 300mm, bore = 200mm, piston speed = 3.5m/s, torque = 630Nm, mechanical efficiency = 30%, indicated thermal efficiency = 30% and calorific value of the fuel=43,900kJ/kg. Calculate the mean effective pressure and mass of fuel consumed per hour. [**10]**

Ans: Data – 2M

Formula – 2M

Engine speed = 2M

Mean effective pressure – 2M

Mass of fuel consumed per hour – 2M

Engine speed = 350rpm
BP = 23.09 KW
IP = 76.96 KW
MEP = 27.99 bar
m_f = $5.84*10^{-3}$ kg/sec or 21.03kg/hr

8. A single cylinder 4 – stroke engine has a swept volume of 4.5litres. The mean effective pressure is 0.65MPa and the engine speed is 505rpm. If there are 250 explosions per minute and the brake torque is 176Nm, find indicated power and brake power of the engine. **[10]**

Ans: Data – 2M

Formula – 2M

Indicated Power – 3M

Brake Power – 3M

IP = 12.18 KW
BP = 9.307 KW

Que.1 (i)

Brake Power (B.P.)

It is the power developed by the engine at the output shaft; i.e., the net power available at the crank shaft.

$$BP = \frac{2\pi N T}{60000} \quad KW$$

N → speed of engine (rpm)

T → Torque in N-m

Torque is measured by using either belt or rope brake dynamometer

$$T = (W - S) R$$ using rope brake dynamometer

W → suspended weight / dead weight (N)

S → spring balance reading (N)

(W − S) → effective load on brake drum (N)

R → radius of brake drum (m)

$$T = (T_1 - T_2) R \quad Nm$$ using belt dynamometer

T_1 → Tension in the tight side of the belt in N

T_2 → Tension in the slack side of the belt in N

R → Radius of the drum/pulley (m)

QUE .1(ii)

Indicated Thermal Efficiency (η_{ith}):

It is defined as the ratio of indicated power to the heat supplied by the combustion of fuel.

$$\eta_{ith} = \frac{IP}{m_f \times CV} \times 100 \ \%$$

IP → Indicated power (KW)

heat supplied = $m_f \times CV$

m_f → mass flow rate of fuel (kg/sec)

CV → Calorific value of fuel (KJ/kg)

Calorific value of fuel is defined as the amount of heat liberated when one kg of fuel is burnt at standard atmospheric pressure & temperature.

Brake Thermal Efficiency (η_{bth})

It is defined as the ratio of brake power to the heat supplied by the combustion of fuel.

$$\eta_{bth} = \frac{BP}{m_f \times CV} \times 100 \; \%$$

BP → Brake power (KW)

m_f → mass flow rate of fuel (kg/sec)

CV → calorific value of fuel (KJ/kg)

Que. 1(iii)

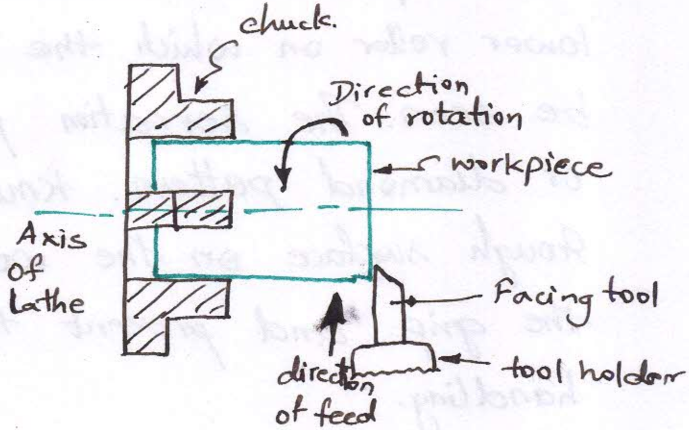
Ice making capacity is defined as the capacity of the refrigerating system to make ice beginning from water (at room temp.) to solid ice. Its unit is kg/hr.

Que. 1(iv)

The rating of the refrigeration system is given by a unit of refrigeration known as "tonne of refrigeration" which is defined "as the quantity of heat absorbed in order to form one tonne of ice ~~from~~ in 24 hours when the initial temperature of the water is 0°C."

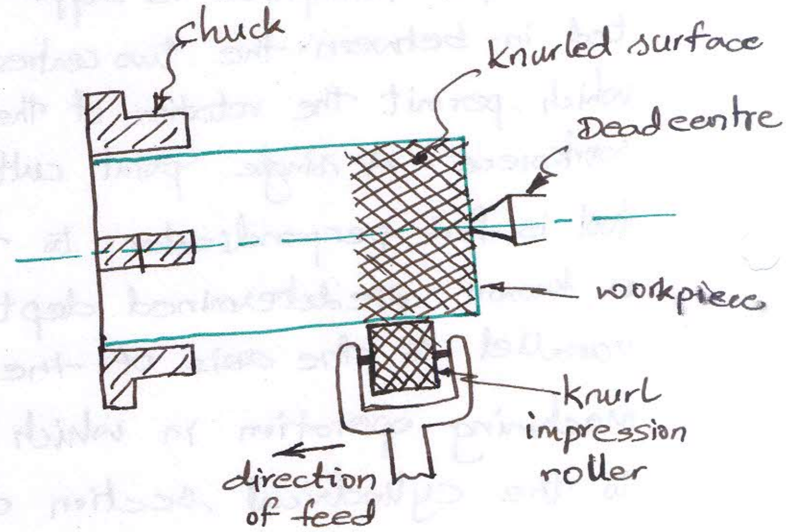
Que.1(b) **Facing**

Facing is an operation performed on the lathe to generate either flat surfaced or shoulders at the end of the workpiece.



In facing operation, the direction of feed given is perpendicular to the axis of the lathe. The workpiece is held in the chuck and the facing tool is fed either from outer edge of the workpiece progressing towards the center or vice-versa. The cutting tool is held by a tool holder in a tool post. Axial movement of the tool can be avoided by locking of the carriage. From the Jaws of the chucks, the length extended should not be more than 1.5 times the diameter of the work. The finishing speeds and feeds are calculated w.r.t. the largest workpiece diameter.

Knurling

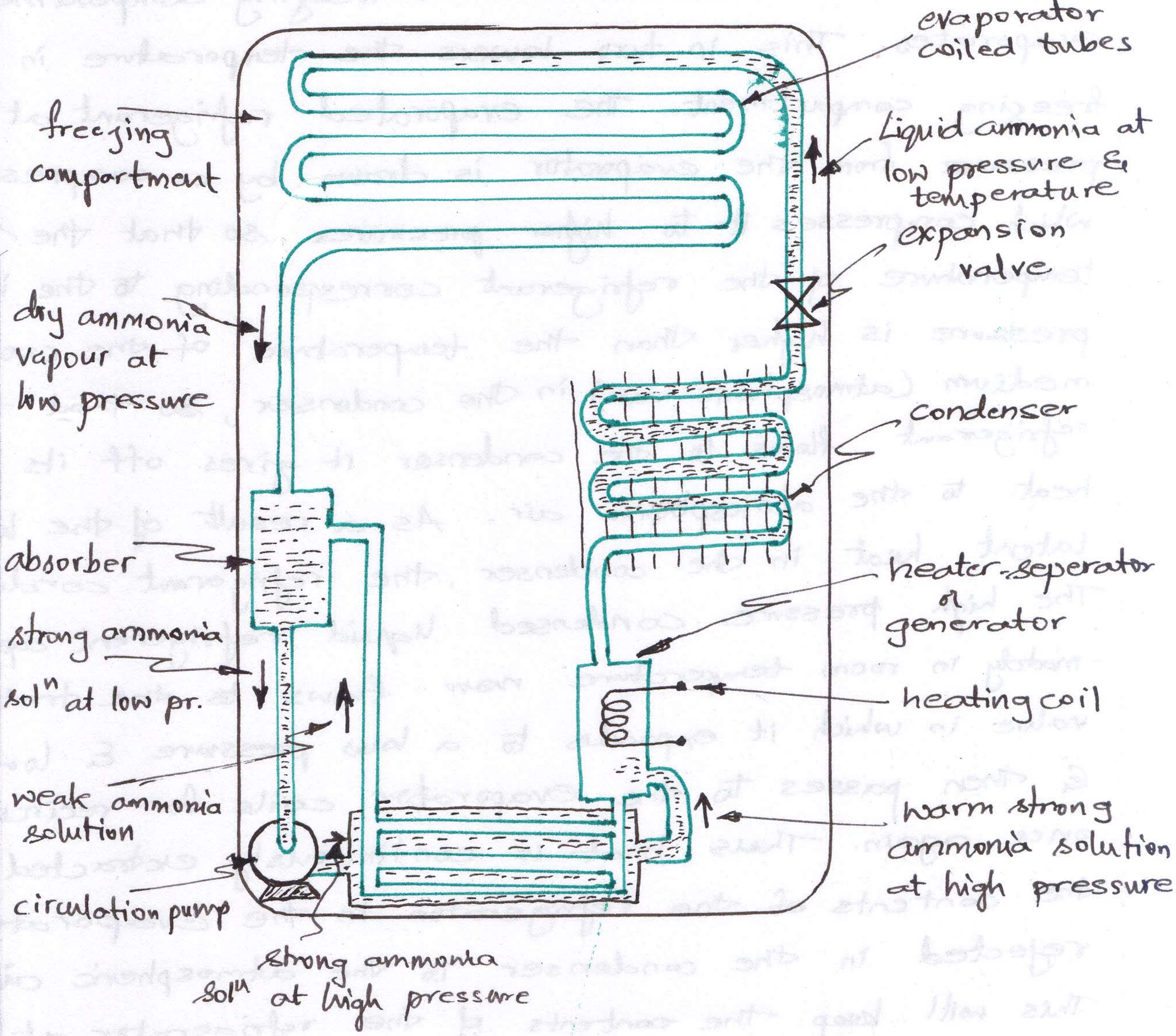


Knurling is an operation performed on the lathe to generate serrated surfaces on the workpiece by using a special tool called knurling tool which impresses its pattern on the workpiece. It consist of one upper roller and one lower roller on which the desired impression patter can be seen. The serration pattern can be straight lines or diamond pattern. knurling is done to provide a rough surface on the workpiece in order to increase the grip and prevent the part from slipping while handling.

The knurling tool's upper & lower rollers heads are made to touch the surface of the workpiece to be knurled. The workpiece is supported at both ends. Usually a low speed of about 60 to 80rpm with a feed of about 0.38 to 0.76 mm/rev. of the spindle is prescribed for knurling operation.

Que.2

Vapour Absorption Refrigeration



A vapour absorption system makes use of the ability of a substance, called absorbent to absorb large volumes of the vapour of a refrigerant even when cold and reduce it to a liquid, and subsequently give off its vapours when heated.
Water which has this ability is the mostly used absorbent, and since ammonia readily dissolves in water and vapourises when its solution is heated, is the commonly used refrigerant in vapour absorption refrigerator.

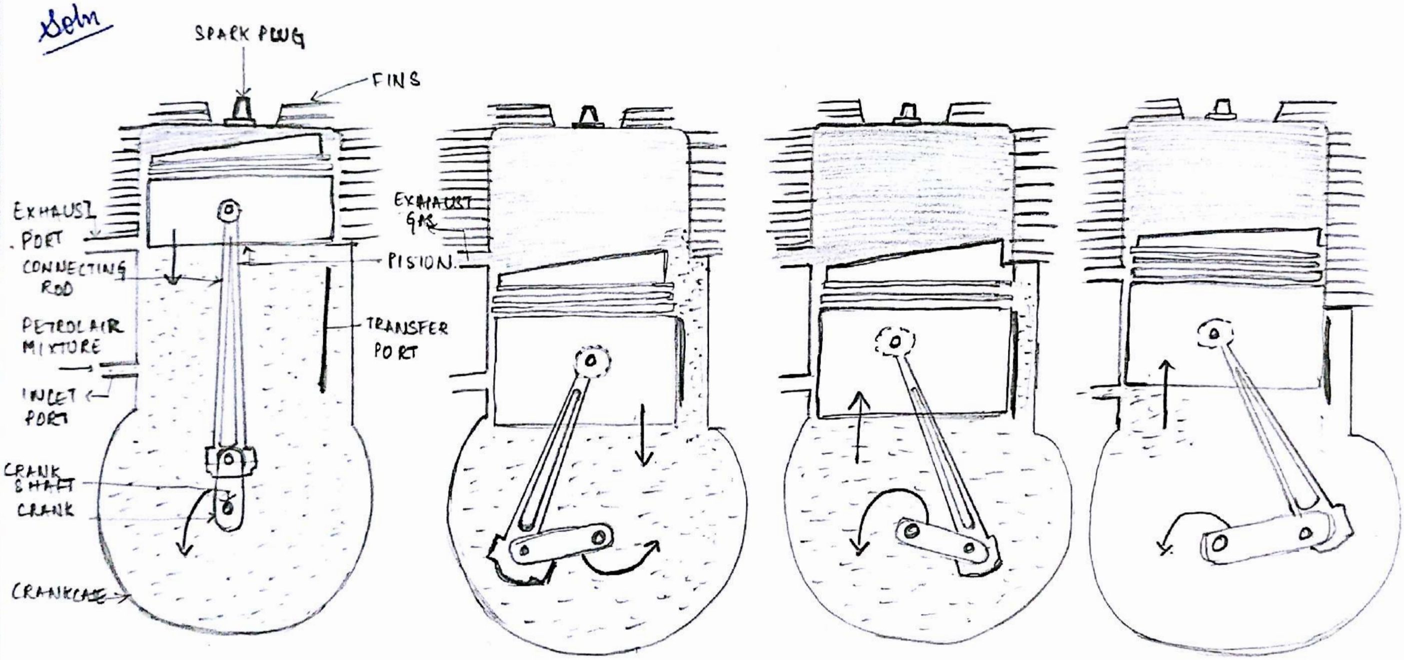
This type of refrigerator consists of an absorber, a circulation pump, heat exchanger, heater cum seperator, condenser, expansion valve & evaporating coiled tubes.

Dry ammonia vapour is dissolved in the cold water contained in the absorber, which will produce a strong ammonia solution. A circulation pump, draws the strong ammonia solution from the absorber and pumps it to the heat exchanger, where it is warmed by the warm weak ammonia solution which is flowing back from the heater-seperator. From the heat exchanger, the warm high pressure strong ammonia is passed to the heater-cum seperator provided with the heating coils. Heating of the high pressure strong ammonia solution will drive out the ammonia vapour from it and consequently the solution in the heater-seperator becomes weak which intuan flow back to the heat exchanger and then to the absorber. The high pressure ammonia vapour from the heater-seperator now passes to a condenser, where it is condensed. The high pressure ammonia liquid is now expanded to a low pressure and low temperature in the trottle valve. Then the low pressure condensed ammonia liquid at low temp. is passed into the evaporator coils provided in the freezing compartment, where it absorbs the heat & evaporates. The low pressure ammonia vapour from the freezing compartment is passed again to the absorber where it is reabsorbed by dissolving in water. and recirculated to repeat the cycle continuously.

Que.3

3. With a neat sketch explain the working of 2 stroke petrol engine with the help of P-V diagram

Soln



A
Beginning of the first stroke

B
Piston uncovers transfer port during the first stroke

C
Transfer port covered

D
Compression commenced

FIRST STROKE

SECOND STROKE

→ FIRST STROKE

At the beginning of first stroke the piston is at the cover end. It moves from the cover end to crank end. The spark plug ignites the compressed petrol and air mixture. The combustion of petrol will release the hot gases which increases the pressure in the cylinder. The high pressure combustion gases force the piston downwards. The piston performs the power stroke till it uncovers the exhaust port. During the earlier part of this stroke which is performed by the pressure of the combustion gases exerted on it, the power is produced. The combustion gases which are still at a pressure slightly higher than the atmospheric pressure escape through the exhaust port. As soon as the top edge of piston uncovers the transfer cylinder port. The fresh petrol air mixture flows from the crankcase into the cylinder. The fresh petrol air mixture which enters the cylinder drives out the spent exhaust gases through the exhaust port. This driving out of exhaust gases by the incoming fresh charge is called scavenging. This will continue till the piston covers both the exhaust and transfer ports during the next ascending stroke. The crankshaft rotates by half rotation.

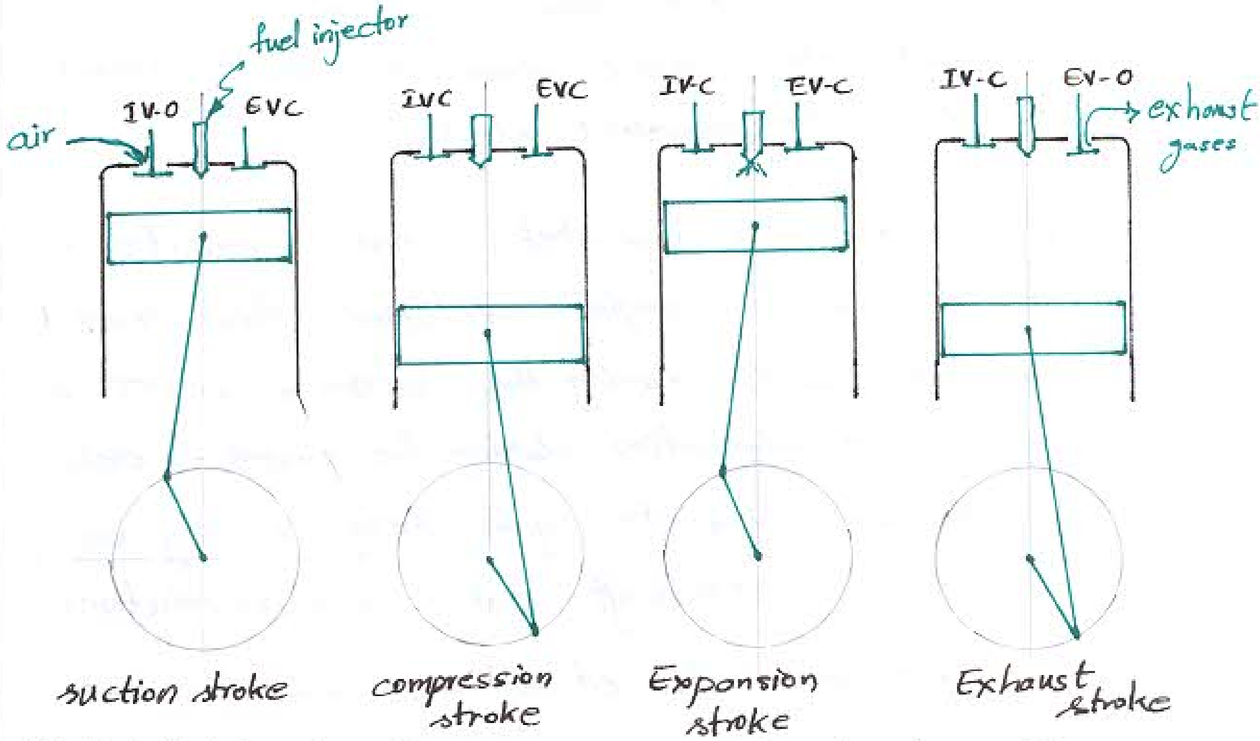
→ SECOND STROKE.

In this stroke the piston ascends and moves from crank end to cover end. When it covers the transfer port, the supply of petrol air mixture is cut off and then when it moves further up it covers the exhaust port completely stops the scavenging. Further ascend of piston will compress the petrol air mixture in cylinder. The ratio of compression ranges from 1:7 to 1:11. After the piston reaches the cover end the first strok as explained earlier repeats again. The crankshaft rotates by half rotation.

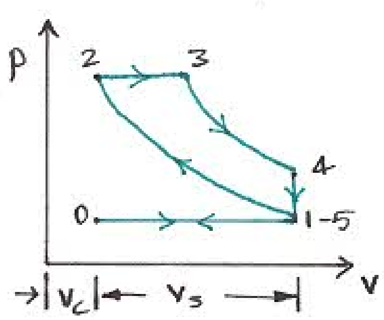
Que.4

Four - Stroke Compression - Ignition Engine

The four-stroke CI engine is similar to the four-stroke SI engine but it operates at a much-higher compression ratio. In the CI engine during suction stroke, air, instead of a fuel-air mixture, is inducted.



IV-O : Inlet valve open
IV-C : Inlet valve close
EV-O : Exhaust valve open
EV-C : Exhaust valve close



$0 \to 1$ & $5 \to 0$: constant pressure process
$1 \to 2$: isentropic process
$2 \to 3$: constant pressure process
$3 \to 4$: isentropic process
$4 \to 1$: constant volume process

Suction Stroke : suction stroke ($0 \to 1$) in PV-diagram, starts when the piston is at the top dead centre and about to move downwards. The inlet valve is opened and the exhaust valve is in closed position as shown in fig (a). Due to the suction created by the motion of the piston towards BDC, the charge consisting of air is drawn into cylinder.

Compression stroke: compression stroke $1 \rightarrow 2$ in PV diagram. During this stroke both inlet & exhaust valves are in closed position as shown in fig (b). The piston moves from BDC to TDC compressing the entire cylinder volume into the clearance volume.

Expansion stroke: Fuel injection starts nearly at the end of the compression stroke. The rate of injection is such that combustion maintains the pressure constant inspite of the piston movement on its expansion stroke increasing the volume. Heat is assumed to have been added at constant pressure ($2 \rightarrow 3$ in PV diagram). After the injection of fuel is completed the products of combustion expand. Result in piston movement from TDC to BDC as shown in fig-(c) ($3 \rightarrow 4$) in PV diagram. Both the valves remain closed during the expansion stroke.

Exhaust stroke: The piston travelling from BDC to TDC pushes out the products of combustion. The exhaust valve is open & the intake valve is closed during the stroke, fig(d). stroke $5 \rightarrow 0$ in PV diagram.

Since this engine requires four strokes to complete one working cycle, it is called four stroke engine. The crankshaft makes two revolutions to complete one cycle. The power is developed in every alternate revolution of the crankshaft.

Compression ratio of CI engine is between 16 to 22

Que .5(a)

4. Differentiate between a 4 stroke and 2 stroke IC engines.

Sl.No.	Principles	4-Stroke	2 Stroke
1.	Number of strokes per cycle	four separate strokes of the piston to complete one cycle.	two strokes of the piston to complete one cycle of operation
2.	Power	Every alternate revolution	Every revolution of crankshaft.
3.	Admission of charge	Directly admitted into the engine cylinder	first admitted into crankcase & then transfered to engine cylinder
4.	Exhaust gases	The exhaust gases are driven out through the outlet by the piston during exhaust stroke	The exhaust gases will be expelled out of cylinder by scavenging operation by the incoming fresh charge
5.	Values	The inlet and the exhaust are opened and closed by mechanical values.	The piston itself opens and closes the inlet, transfer and the exhaust ports.
6.	Crankcase	Although the crankcase of a four stroke engine is closed, it will not be hermetically sealed	Since the charge is admitted into the crankcase it is hermetically sealed.
7.	Direction of rotation of the crankshaft	The crankshaft rotates only in one direction.	The cranshaft can rotate in either directions.
8.	Lubricating oil consumption	less and less coolant.	more and cooling.
9.	Mechanical efficiency	low because of the increased number of strokes and more number of mechanical parts	high because there are only two strokes per cycle and absence of the some mechanical parts.
10.	Noise	Since the exhaust takes place gradually during the exhaust stroke, the noise will be less	The opening of the exhaust port releases the exhaust gases suddenly, and hence noise will be more
11.	Uses.	Four strokes are used in slow speed high power applications like, cars, trucks, tractors, jeeps, buses etc.	Two stroke engine are used for high speed and low power applications such as mopeds, scooters, motorcycles etc.
12.	Thermal efficiency	high	low.
13.	Cost	high	low.

Que.5(b)

5. Differentiate between petrol & diesel engines.

Sl.No	Principles	Petrol Engines [S.I engine]	Diesel engines (C.I engine)
1.	Fuel used	Petrol	Diesel.
2.	Theoritical cycle of operation	Otto cycle	Diesel cycle.
3.	Admission of fuel	During the suction stroke itself the petrol is 1st admitted in the carburettor, where it gets mixed with the air & then mixture enters the cylinder	The diesel oil is pressurised by the fuel pump and then injected into the engine cylinder by the fuel injector at the end of compression stroke.
4.	charge drawn during the suction stroke	Air and petrol mixture is drawn during the suction	only air is drawn during the suction stroke.
5.	Compression ratio	low compression ratio ranging from 7:1 to 12:1	High compression ratio ranging from 16:1 to 20:1.
6.	Ignition of the fuel	The compressed air & petrol is ignited by spark plug This type of ignition is called spark ignition	The ignition of diesel is accomplished by compressed air which have been heated due to high compression, to the temperature higher than the ignition temperature, Compression ignition.
7.	Governing	The quantitative method of governing is employed in petrol engines.	The qualitative methods of governing is employed in diesel engines
8.	Engine speed	High engine speeds of about 3000 rpm	Low engine speeds ranging from 500 to 1500 rpm
9.	Power output efficiency	Because of low compression ratio the power will be less	due to high compression ratio the power will be more
10.	thermal efficiency	the thermal efficiency of petrol engines is lower due to LC ratio	the thermal efficiency of diesel engines is higher due to HC ratio
11.	Noise and vibration	less noise and vibration are almost nil	noise and vibration are high due to higher operating pressure
12.	Uses	Used in scooter, Motor cycle, cars etc	Used in as Trucks, Tractors, Buses & Bulldozers.

Que.6

Air conditioning

Providing a cool congenial indoor atmosphere at all times regardless of weather conditions needed either for human comfort or industrial purposes by artificially cooling, humidifying or dehumidifying, cleaning and recirculating the surrounding air is called air conditioning.

The artificial cooling of air & conditioning it to provide maximum comfort to human beings is called comfort air conditioning.

M.5 (9)

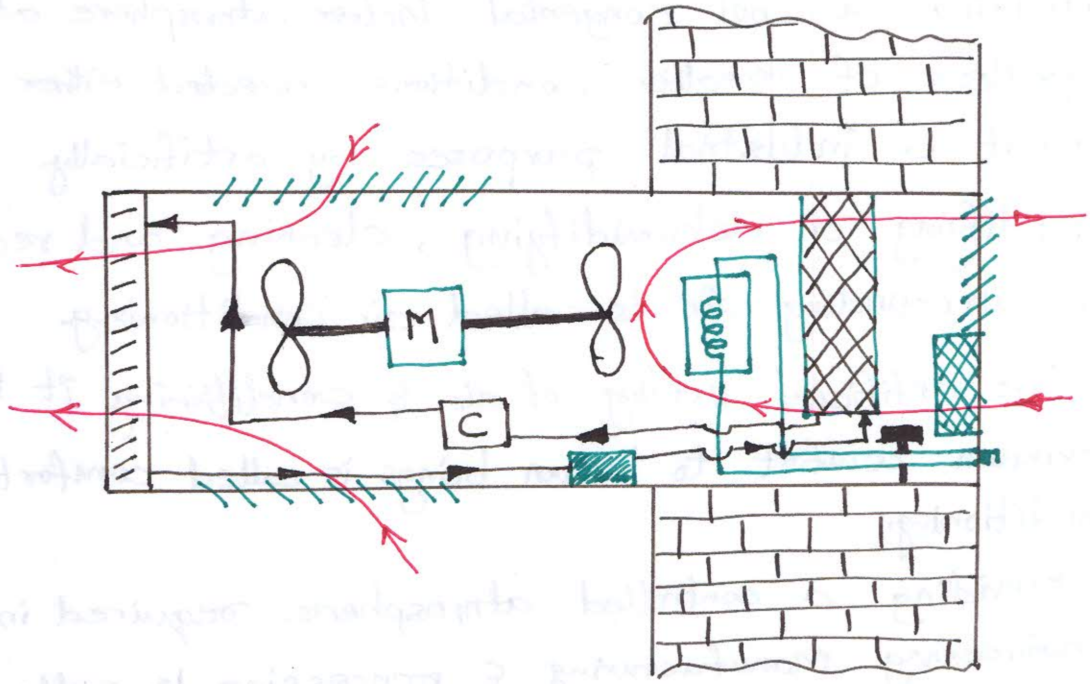
Providing a controlled atmosphere required in some engineering manufacturing & processing is called industrial air conditioning.

Air conditioning is the simultaneous control of temperature, humidity, motion & purity of the atmosphere in confined space.

Principle of air conditioning

An air conditioner continuously draws the air from an indoor space to be cooled, cools it by the refrigeration and discharges back into the same indoor space that needs to be cooled. This continuous cyclic processes of drawing, cooling & recirculation of the cooled air keeps the indoor space cool at the required lower temperature needed for comfort cooling or industrial cooling purposes.

Room Air Conditioner



(7) Given data:

$L = 300\ mm = 0.3\ m$

$d = 200\ mm = 0.2\ m$

$v = 3.5\ m/s$

$T = 630\ Nm$

$\eta_m = 30\% = 0.30.$

$\eta_{ith} = 30\% = 0.30.$

$CV = 43900\ kJ/kg$

To find:

$P_M = ?\ ;\ m_f = ?$

Soln:

$$v = \frac{2LN}{60}\ m/s$$

$$N = \frac{v \times 60}{2 \times L} = \frac{3.5 \times 60}{2 \times 0.3} = 350\ rpm$$

$$IP = \frac{P_M \times L \times A \times n_i}{60 \times 1000}\ kW$$

$$P_M = \frac{I.P \times 60 \times 1000}{L \times A \times n_i}\ N/m^2$$

$$BP = \frac{2\pi NT}{60 \times 1000} = \frac{2\pi \times 350 \times 630}{60 \times 1000}$$

$$\boxed{BP = 2309\ kW}$$

we know, $\eta_m = \frac{B.P}{IP}$.

$IP = \frac{BP}{\eta_m} = \frac{23.09}{0.3} = 76.96$ kW.

$IP = 76.96$ kW

$P_m = \frac{76.96 \times 60 \times 1000}{0.3 \times \frac{\pi}{4} (0.2)^2 \times \left(\frac{350}{2}\right)}$

($n_i = N/2$ for 4 stroke engine)

$= 27.99 \times 10^5$ N/m2

$P_m = 27.99$ bar

$\eta_{ith} = \frac{IP}{m_f \times CV}$

$0.3 = \frac{76.96}{m_f \times 43900}$

$\frac{kJ/s}{(kg/s) \cdot kJ/kg}$

$m_f = \frac{76.96}{(0.3 \times 43900)}$

$m_f = 5.84 \times 10^{-3}$ kg/s

or $m_f = 21.036$ kg/hr.

⑧ Given:

Swept Volume (L. A) = 4.5 Litres

$= 4.5 \times 10^{-3}\ m^3$

$P_m = 0.65\ MPa = 0.65 \times 10^6\ N/m^2$

$N = 505\ rpm$

$n_i = 250$ explosions/min

$T = 176\ Nm$

To find:

(i) Indicated Power (ii) Brake Power

Soln.

$$I.P = \frac{P_m \cdot L \cdot A \cdot n_i}{60 \times 1000}\ kW$$

$$= \frac{(0.65 \times 10^6) \times (4.5 \times 10^{-3}) \times 250}{60 \times 1000}$$

$$\boxed{IP = 12.1875\ kW}$$

$$BP = \frac{2\pi N T}{60 \times 1000}\ kW$$

$$= \frac{2\pi \times 505 \times 176}{60 \times 1000}$$

$$\boxed{BP = 9.307\ kW}$$