1. (5x4=20)

2-Stroke Engine	**4-Stroke engine**
Cheaper and easier to manufacture.	More expensive and more difficult to manufacture because of additional parts like valves and lubrication systems.
One revolution of the crankshaft for every power stroke	Two revolutions of the crankshaft for every power stroke
Bigger ratio in terms of power to weight	Smaller ratio in terms of power to weight
Engines are lighter and noisier.	Engines are heavier because they have flywheels which are heavy and less noisy.
Uses ports or holes for inlet and outlet of the fuel.	Uses valves for inlet and outlet of the fuel
More wear and tear because of poor lubrication.	Less wear and tear because it has a separate lubricating system.
Lower thermal efficiency	Higher thermal efficiency
It emits more smoke making it less fuel-efficient.	It emits less smoke making it more fuel-efficient.
Produces higher torque	Generates lesser torque
More lubricating oil is required because some oil burns together with the fuel.	Requires less lubricating

b)The main components of a spark-ignition engine are as follows:

- **Inlet Valve:** Air-fuel mixture enters the cylinder through the inlet valve.

- **Exhaust Valve:** The burnt or exhaust gases produced in the power stroke escapes out through the exhaust valve.
- **Spark Plug:** It produces a spark at the end of the compression stroke, which ignites the compressed air-fuel mixture.
- **Cylinder:** It is a hollow cylinder in which the piston reciprocates.
- **Piston:** It is a moving part of the engine that performs reciprocating motion and transmits the power generated during power stroke to the crankshaft through the connecting rod.
- **Connecting Rod:** It is that part of the engine which connects the piston to the crankshaft.
- **Crankshaft:** It is used to convert the reciprocating motion of the engine into rotary motion.

c)The **purpose** of the **supercharging** in the IC engine is as follows:- To provide the compressed (High density) air to engine. To increase volumetric and mechanical efficiency of the engine.

d)Bharat stage emission standards (BSES) are emission standards instituted by the Government of India to regulate the output of air pollutants from internal combustion engines and Spark-ignition engines equipment, including ...The standards and the timeline for implementation are set by the Central Pollution Control Board under the Ministry of Environment & Forests and climate changeThe standards, based on European regulations were first introduced in 2000.

Ans. 2a) The primary task of the development engineer is to reduce the capital and running cost of the engine. This involves trial of various design concepts. The parameters are so enormous and different in nature that it is physically impossible to take care of all of them during the design of the engine.Therefore it is necessary to conduct the test on the engine and determine the measures which should be taken to improve the engine performance. ***(4)***

b) Compressed Natural Gas (CNG) is made by compressing natural gas (which is mainly composed of methane, to less than 1% of the volume it occupies at standard atmospheric pressure. • Compressed natural gas (CNG) (methane stored at high pressure) is a fuel which can be used in place of gasoline (petrol), Diesel fuel . CNG is used in traditional petrol/internal combustion engine vehicles that have been modified, or in vehicles specifically manufactured for CNG use: either alone (dedicated), with a segregated liquid fuel system to extend range (dual fuel), or in conjunction with another fuel (bi-fuel). It can be used in place of petrol (gasoline), diesel fuel, and liquefied petroleum gas (LPG). CNG combustion produces fewer undesirable gases than the

aforementioned fuels. In comparison to other fuels, natural gas poses less of a threat in the event of a spill, because it is lighter than air and disperses quickly when released. (4)

1. Radiator

Radiator is an iron-shaped composers used to cool coolant. The working principle of the radiator is to move the temperature from water to free air.

2. The Radiator Cap

The radiator cap serves as the cover of the upper tank radiator while keeping the air pressure inside the cooling system. This lid construction is not like a bottle cap or other lid, because there is a pressure regulating mechanism then there are other parts inside this lid.

3. Radiator hoses

The function of radiator hoses are to supply radiator coolant from the engine to the radiator and back to the engine. Although its function is only channeling the coolant, this parts can not be underestimated.

4. Thermostat

Thermostat is a part that have function like valve. This valve will close and open the port between water jacket and high temperature radiator hose. It works to speed up the engine to get the working temperature.

5. Water jacket

Water shell or more familiarly known as water jacket serves as a place to absorb engine heat evenly. The name of the water jacket is just a term that leads to the water channel around the engine.

6. Reservoir tanks

This tube serves to store evaporative cooling water. When the engine is in high temperatures, the coolant will evaporate and result in increased air pressure within the system.

7. Cooling fan

The cooling fan works to take down the radiator temperatures. The working principle of cooling fan is by flowing the air from outside through radiator fins.

d)An Internal combustion engine is a device that uses the chemical energy released by the fuel in the form of heat for producing mechanical work. It may be defined as a relatively rapid chemical combination of hydrogen and carbon in the fuel with the oxygen in the air resulting in the liberation of energy in the form of heat. Combustion is a very complicated phenomenon and has been a subject of intensive research for many years.

Conditions necessary for combustion are:-

- The presence of a combustion mixture.
- Some means of initiating combustion.
- Stabilization and propagation of flame in the combustion chamber.

Types:Normal and Abnormal combustion

Normal combustion is the process where the fuel is burned layer by layer i.e. in a wave form by the help of spark only. And **abnormal combustion** is the process where the fuel burns not only by spark but also by self ignition process where a no. of waves of flames are produced from different parts of the cylinder.

3a)Here are some of our most common fuel injection issues.

- Clogged Fuel Injectors.
- Dirty Fuel Injection.
- Unable to Open Injector.
- Unable to Close the Injection.
- Leaking Fuel Injection.
- Misfiring Engine.
- Uneven Power in the Engine.
- Diminished Fuel Economy.

(4)

b)Engine performance is an **indication of the degree of success of the engine performing its assigned task**, i.e. the conversion of the chemical energy contained in the fuel into useful mechanical work.

Engine performance is important to **maintain the vehicle's health and the safety of a vehicle's drivers and passengers**. A vehicle's low power and performance signals there may be problems under the hood.

Following are the different parameters of engine performance:

1. Power
2. Horse Power
3. Torque

4. Bore and Stroke
5. Piston displacement
6. Engine displacement
7. Compression Ratio
8. Indicated Horse Power (I.H.P)
9. Brake Horse Power (B.H.P)
10. Frictional Horse Power (F.H.P)
11. Indicated Thermal Efficiency
12. Brake Thermal Efficiency
13. Mechanical Efficiency
14. Volumetric Efficiency
15. Relative Efficiency
16. Mean Effective Pressure
17. Mean Piston Speed
18. Specific Power Output
19. Specific Fuel Consumption
20. Air-Fuel Ratio
21. Calorific Value of the Fuel

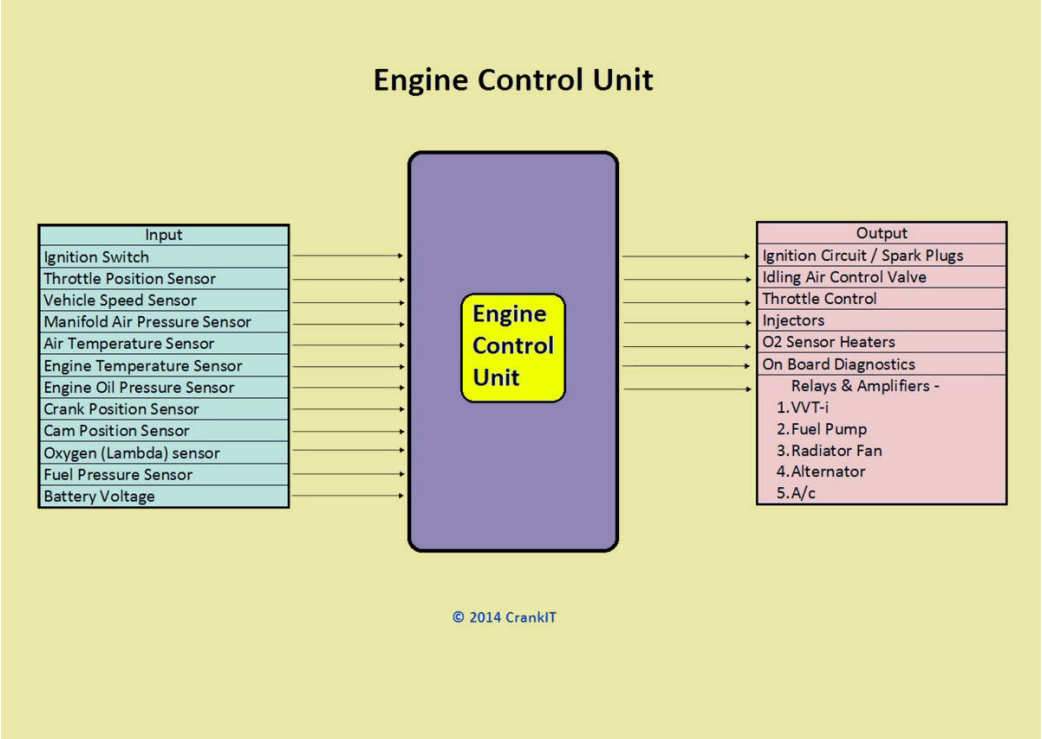
(4)

c)EMS stands for Engine Management System, consisting of a wide range of electronic and electrical components such as sensors, relays, actuators, and an Engine Control Unit. They work together to provide the Engine Management System with vital data parameters. These are essential for governing various engine functions effectively. Furthermore, modern-day engine technologies incorporate the EMS. These include MPFi & GDi systems in Petrol engines and CRDi systems in diesel engines for improved performance.

Engine Management System: What is ECU/ECM?

ECU stands for Engine Control Unit and ECM for Engine Control Module. Both are the same. However, it is also a generic term for any Electronic Control Unit/Module.

d)the main methods of SI engine emissions control are:



(6)

Ans 4a)SAE (Society of Automotive Engineers) ratings classify lubricating oils according to their viscosity. The method assigns a number to an oil whose viscosity at a given temperature falls in a certain range.

- In order to assign the numbers two temperatures are used as reference: one is -18°C (0°F) and 99°C (210°F).
- Oils defined in terms of viscosity at -18°C, such as SAE 5W, 10W and 20W grades, provide starting in cold climates easy.
- Oils defined in terms of viscosity at 99°C, such as SAE 20, 30, 40 and 50 grades, work satisfactorily in normal and hot climates.
- These numbers merely classify the oils and are not indicators of the oil quality.
- Some oils, called multi-grade oils, are developed to exhibit more than one viscosity at different temperatures. Eg. SAE 20W/50 oil has viscosity equal to SAE 20W at -18°C and viscosity equal to SAE 50W at 99°C. ***(4)***

b)An exhaust gas oxygen sensor, also known as lambda sensor, is a device for measuring the oxygen proportion in the exhaust gas being analyzed.

The sensor is part of the emissions control system and provides data to the engine management computer. The input from the oxygen sensor is used to balance the fuel mixture.

The exhaust oxygen sensor includes a sensing portion that is exposed to the exhaust gas stream to detect residual oxygen in the exhaust gas and transmit the data to the control unit.

Working Principle

The exhaust oxygen sensors produce a voltage signal that identifies the amount of unused oxygen in the exhaust. Heating a zirconia element in the tube generates a voltage that varies according to the amount of oxygen in the exhaust vessel to that residing in the outside environment.

The output voltage is compared to a preset level by the control unit. The output of the sensor ranges from 0.2 to 0.8V, and perfectly balanced fuel mixture of 14.7 parts of air to 1 part of fuel provides an average reading of around 0.45 V. However, the output of the sensor does not remain constant and varies from rich to lean.

(4)

d)GIVEN DATA:-

Dia of cylind er (d)=300mm=0.3m

Engine stroke(l)=500mm=0.5m

Clearance volume(vc)=6750/1003=6.75 m3

Explosions pe r minute(n)=100/minute=i.67/sec

Pmin=765 KN /m2

Brake drum dia(D1)=1.5m

Rope dia(d1)= 0.025m

Work load on the brake(w)=190kg=1.86KN

TO FIND:-

Compression rati o (r)

Mechanical efficiency (ηmech)

Indicated thermal efficiency (ηit)

Air standard efficiency (ηair)

Relative efficiency (ηrel)

SOLUTION:-

(1).Compression Ratio (r):-

$$r = \left(\frac{V_s}{V_c}\right) + 1$$

$$= \left(\frac{l \times a}{vc}\right) + 1$$

$$= \frac{0.5 \times \left(\frac{\pi}{4}\right) 0.3^2}{0.75 \times 10^{-3}} + 1$$

$$= 5.23 + 1$$

$$(r) = 6.23$$

(2).Air Standard Efficiency (η_{air}):-

$$\eta_{air} = 1 - \left(\frac{1}{r^{\gamma-1}}\right)$$

$$= 1 - \left(\frac{1}{6.23^{1.4-1}}\right)$$

=51.89%

(3).Indicated Thermal Efficiency (η_{it}):-

$$(\eta_{it}) = \frac{IP}{FC \times Cv}$$

Here, indicated power (IP)= $P_{mi} \times l \times a \times n \times k$

=765x0.5x0.0706x1.67x1

=45.09KW

Therefore, $\eta_{it} = \frac{45.09}{\left(\frac{80}{5600}\right) \times 22515}$

=24.03%

(4).Relative Efficiency (η_{rel}):-

$$(\eta_{rel})=\acute{\eta}it/\acute{\eta}air$$

$$=\frac{24.02}{51.85}$$

$$=46.30\%$$

(5).Mechanical Efficiency (η_{mech}):-

$$(\eta_{mech})=\frac{BT}{IP}$$

$$=\frac{18.99}{24.02}$$

$$=79.02\%$$

(6)