Subject Code

- Any - ▼

Chapter Name

- Any - ▼

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Examination:

Que.No	Marks	
Q 3 a)	4	Question: **State the norms of Bharat stage III and IV.** Answer: In year 2010 – Bharat Stage III Emission Norms for 2-wheelers, 3-wheelers and 4-wheelers for entire country whereas Bharat Stage – IV (Equivalent to Euro IV) for 13 major cities for only 4- wheelers. Bharat Stage IV also has norms were implemented for 4-wheelers for 13 major cities for only 4-wheelers. Currently, BS-IV petrol and diesel are being supplied in whole of Northern India covering Jammu and Kashmir, Punjab, Haryana, Himachal Pradesh, Uttarakhand, Delhi and parts of Rajasthan and western UP. The rest of the country has BS-III grade fuel.

Emission norms for Diesel Engine Vehicles, g/kWh

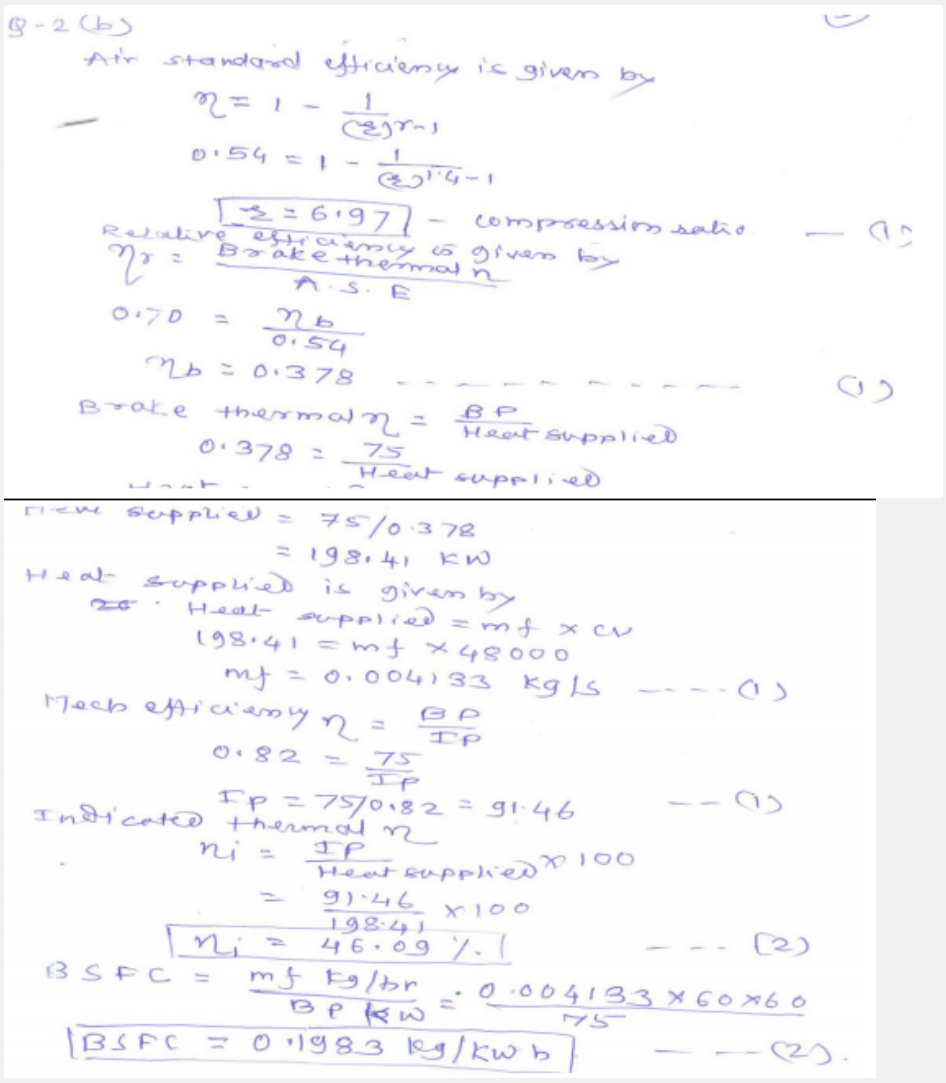
Year	Standard	CO	HC	NO_x	PM
2010	BS III	2.1	0.66	5.0	0.10
		5.45	*0.78*	*5.0*	*0.16*
2010	*BS IV*	*1.5*	*0.46*	*3.5*	*0.02*
		4.0	*0.55*	*3.5*	*0.03*

Emission norms for Petrol Vehicles, g/km

Year	Standard	CO	HC	HC+NO_x	NO_x
2010	BS III	2.3 4.17 5.22	0.20 0.25 0.29	–	0.15 0.18 0.21
2010	BS IV	1.0 1.81 2.27	0.1 0.13 0.16	–	0.08 0.10 0.11

Examination: 2017 SUMMER

Que.No	Marks	
Q 1b)(b)	6	Question: **Explain Morse test conducted to find the frictional power of a multi-cylinder petrol engine** Answer: ## Morse Test Morse test is a method to measure the frictional power of a multicylinder SI engine. Morse Test – This test carried out on multi cylinder I.C. engine. In this test, first engine is allowed to run at constant speed and brake power of engine is measured when all cylinders are working and developing indicated power. (Considering Four cylinders) I1+I2+I3+I4 = (BP)engine +(F1+F2+F3+F4) Where I1, I2, I3 and I4 – Indicated power of four cylinders (BP)engine – Brake power of engine when all cylinders are working F1, F2, F3, F4 – Frictional power of all four cylinders Then the first cylinder is cut off by short circuiting spark plug in case S.I. engine (or cutting fuel supply in case C.I. engine). This causes the speed to drop due to non firing of first cylinder. It should be noted that although first cylinder is not producting power still it is moving up and down so its frictional power must be considered. This speed is once again maintained to its original value by reducing load on the engine ----------

Que.No	Marks	
Q 2 b)	8	Question: **The following data refers to a trial conducted on 4-stroke petrol engine Air-fuel ratio (by mass) = 15.5 : 1 Heat value of fuel = 48000 kJ/kg Mechanical efficiency = 82% Air standard efficiency = 54% Relative efficiency = 70% Volumetric efficiency = 80% Speed = 240 rpm Brake power = 75 kW Calculate : i) Compression ratio ii) Indicated thermal efficiency iii) Brake specific fuel consumption.** Answer:  ----------

Q-2 (b)

Air standard efficiency is given by

$$\eta = 1 - \frac{1}{(r)^{\gamma-1}}$$

$$0.54 = 1 - \frac{1}{(r)^{1.4-1}}$$

$$r = 6.197 \quad \text{– compression ratio} \quad \text{— (1)}$$

Relative efficiency is given by

$$\eta_r = \frac{\text{Brake thermal } \eta}{\text{A.S.E}}$$

$$0.70 = \frac{\eta_b}{0.54}$$

$$\eta_b = 0.378 \quad \text{— (1)}$$

$$\text{Brake thermal } \eta = \frac{BP}{\text{Heat supplied}}$$

$$0.378 = \frac{75}{\text{Heat supplied}}$$

Heat supplied = 75/0.378

= 198.41 KW

Heat supplied is given by

Heat supplied = mf × CV

198.41 = mf × 48000

mf = 0.004133 kg/s — (1)

$$\text{Mech efficiency } \eta = \frac{BP}{IP}$$

$$0.82 = \frac{75}{IP}$$

$$IP = 75/0.82 = 91.46 \quad \text{— (1)}$$

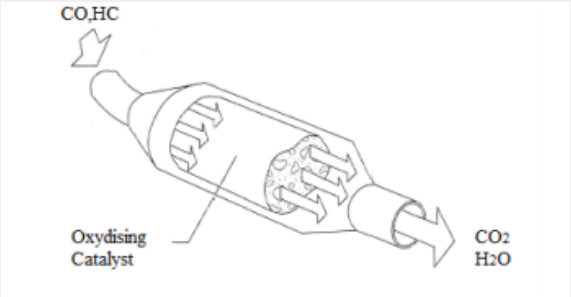
$$\text{Indicated thermal } \eta_i = \frac{IP}{\text{Heat supplied}} \times 100$$

$$= \frac{91.46}{198.41} \times 100$$

$$\eta_i = 46.09\ \% \quad \text{— (2)}$$

$$BSFC = \frac{mf \text{ kg/hr}}{BP \text{ kW}} = \frac{0.004133 \times 60 \times 60}{75}$$

$$BSFC = 0.1983 \text{ kg/kW h} \quad \text{— (2)}.$$

Que.No	Marks	
Q 3 b)	4	Question: **A petrol engine has a cylinder of diameter 60 mm and stroke 100 mm. If the mass of charge admitted per cycle is 2×10 □ 4 kg. Find volumetric efficiency of the engine.** Answer: **b)**Given data:-Dc=60mm=0.06m;L= 100mm = 0.1m; m=0.0002kg we know that swept volume of the piston is, $Vs=\frac{\pi}{4}(0.06)^2 0.1 = 0.283\,X10^{-3}\ m^3$…… Va= volume of charge admitted at NTP $Va=\frac{mRT}{P}=\frac{0.0002\,X\,287\,X273}{1.013\,X10^5}=0.155X\ 10^{-3}\ m^3$…… Volumetric efficiency= $\frac{v_a}{v_s}=\frac{0.155X\ 10^{-3}}{0.283\,X10^{-3}}=0.548\ =\ 54.8\%$……
Q 3 c)	4	Question: **Explain with neat sketch two way catalytic converter.** Answer: C) Catalytic Convertor: -. A catalytic converter is cylindrical unit about the size of small silencer and is installed into exhaust system of vehicle. It converts the harmful gases from the engine into harmless gases and escapes them into atmosphere. Inside converter there is honeycomb structure of ceramic or metal which is coated with alumina base material and therefore a second coating of precious metal platinum, palladium or rhodium or combination of same. As a result of catalytic reaction, the exhaust gases pass over the converter substance, the toxic gases such CO, HC and NOx are converted into harmless CO2, H2 and N2. Two way catalytic converter: Through catalytic action a chemical changes converts carbon monoxide (CO) and hydrocarbon (HC) into carbon dioxide (CO2) and water (oxidation).. 

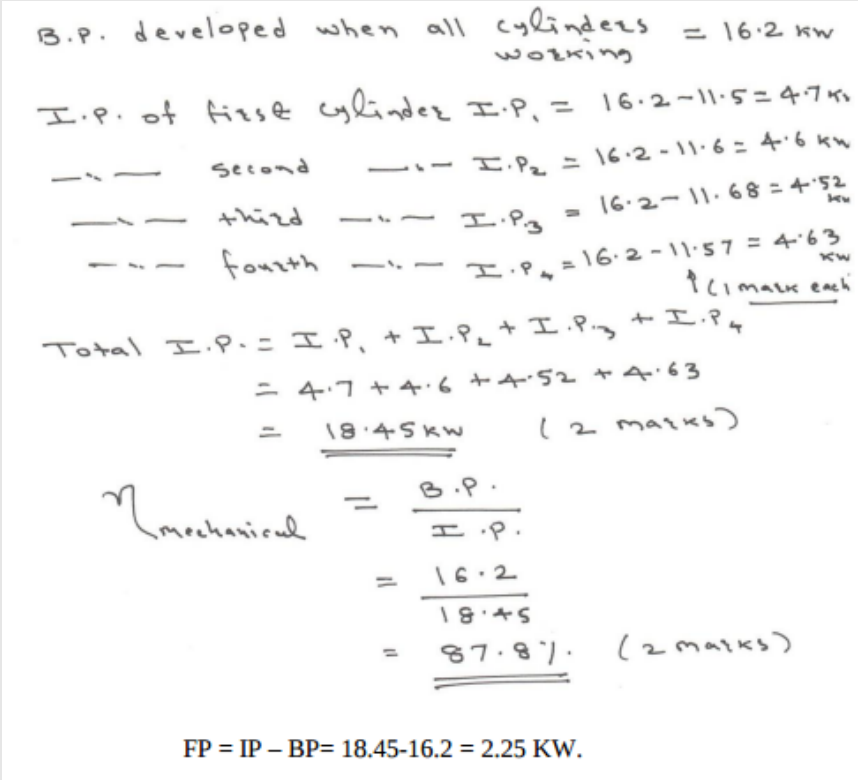
Que.No	Marks	
Q 4a)(a)	6	Question: **a) Define : i) Stroke ii) Bore iii) Piston speed iv) MEP (Mean Effective Pressure).** Answer: a) i) Stroke – Distance travelled by piston from one dead Centre to other dead Centre (Say TDC to BDC). ii) Bore:- The nominal Inner diameter of engine cylinder is called cylinder bore. iii) Piston Speed- Distance traveled by piston in one minute.(= 2LN m/min.) iv) The Mean Effective Pressure (MEP) :-It is a fictitious pressure that, if it operated on the piston during the entire power stroke, would produce the same amount of net work as that produced during the actual cycle. OR The average pressure acting on the piston which will produce the same output as is done by the varying pressure during the cycle ----------

Que.No	Marks	
Q 4b)(I)	6	Question: **Explain how the heat balance sheet for an IC engine is prepared ?** Answer: i) Heat Balance Sheet :-The complete record of heat supplied and heat rejected during a certain time(Say one minute)by an IC engine is entered in a tabulated form called as heat balance sheet. i) Heat supplied by the fuel= Mf x C where Mf= mass of fuel supplied in Kg/min C = Lower calorific value of fuel kj/kg ii) Heat absorbed in IP produced we know that IP produced by IC engine is IP $= \frac{100P_mLAn}{60}$……..kwatt Heat absorbed in IP = $100P_mLAn$……kj/minute……..1M iii) Heat rejected to the cooling water The mass of cooling water, circulating through the cylinder Jackets, as well as its inlet and outle temperatures are measured in order to determine heat rejected to cooling water. Heat rejected to cooling water =$m_wC_w(t_1 - t_2)$….kj/minute……..1M *Where,* $m_w = Mass\ of\ cooling\ water\ suppliedin\ kg/min$ $C_w = specific\ heat\ of\ water$ $t_1 = Inlet\ temperature$ $t_2 = Outlet\ temperature$ iv) Heat carried away by exhaust gases = $m_gC_g\ t$ …. ….kj/min……1M *Where,* $m_g = Mass\ of\ cexhaust\ gasses\ produced\ in\ \ kg/min$ $C_g = specific\ heat\ exhaust\ gases$ $t = Rise\ in\ temperature$ v) Un accounted Heat= It is the difference of Heat supplied by the fuel and Heat absorbed in I produced, Heat rejected to cooling water , Heat carried away by exhaus gases……..1M Table……..1M

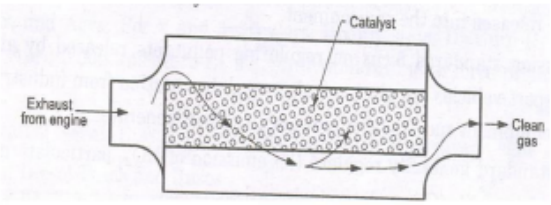
Sr No	Particulars	Heat In	
		Kj	%
	Total Heat Supplied	…….	100
1	Heat absorbed in IP produced		
2	Heat rejected to cooling water		
3	Heat carried away by exhaust gases		
4	Un accounted Heat		

Que.No	Marks	
Q 6 a)	4	Question: **The following results were obtained during Morse test on 4 stroke petrol engine Brake power developed when all cylinders are working = 16.2 kw Brake power developed with cylinder no. 1 cut off = 11.5 kw Brake power developed with cylinder no. 02 cutoff = 11.6 kw Brake power developed with cylinder no. 03 cutoff = 11.68 kw Brake power developed with cylinder no. 04 cutoff = 11.5 kw Calculate mechanical efficiency of the engine.** Answer: Brake Power Engine (BP)engine = 16.2 kW Brake Power developed when 1st Cylinder cut-off (BP)2,3,4 = 11.5 kW Brake Power developed when 2nd Cylinder cut-off (BP)1,3,4 = 11.6 kW Brake Power developed when 3 rdCylinder cut-off (BP)1,2,4 = 11.68 kW Brake Power developed when 4 thCylinder cut-off (BP)1,2,3 = 11.5 kW Indicated Power of 1st cylinder IP1 = (BP)engine - (BP)2,3,4 = 16.2 – 11.5 = 4.7 kW IP2 = (BP)engine - (BP)1,3,4 = 16.2 – 11.6 = 4.6 kW IP3 = (BP)engine - (BP)1,3,4 = 16.2 – 11.68 = 4.52 kW IP4 = (BP)engine - (BP)1,2,3 = 16.2 – 11.5 = 4.7 kW Indicated Power of Engine IP = IP1 + IP2 + IP3 + IP4 = 4.7 + 4.6 + 4.52 + 4.7 = 18.52 kW Mechanical Efficiency of the Engine ηm = (BP / IP) x 100 = (16.2 / 18.52) x 100 = 87.47 % ----------

Examination: 2017 WINTER

Que.No	Marks	
Q 2 c)	8	Question: **The following results were obtained during Morse test on 4-stroke petrol engine. Brake power developed when all cylinders working = 16.2 kW Brake power developed when 1 st cylinder cutoff = 11.5 kW Brake power developed when 2 nd cylinder cutoff = 11.6 kW Brake power developed when 3 rd cylinder cutoff = 11.68 kW Brake power developed when 4 th cylinder cutoff = 11.57 kW Calculate mechanical efficiency and friction power.** Answer:  B.P. developed when all cylinders working = 16.2 kW I.P. of first cylinder $I.P_1 = 16.2 - 11.5 = 4.7$ kW — " — second — " — $I.P_2 = 16.2 - 11.6 = 4.6$ kW — " — third — " — $I.P_3 = 16.2 - 11.68 = 4.52$ kW — " — fourth — " — $I.P_4 = 16.2 - 11.57 = 4.63$ kW (1 mark each) Total $I.P. = I.P_1 + I.P_2 + I.P_3 + I.P_4$ $= 4.7 + 4.6 + 4.52 + 4.63$ $= 18.45$ kW (2 marks) $\eta_{mechanical} = \frac{B.P.}{I.P.}$ $= \frac{16.2}{18.45}$ $= 87.8\%$ (2 marks) FP = IP – BP= 18.45-16.2 = 2.25 KW. ----------
Q 3 c)	4	Question: **State the advantages of lubricant additives (any four).** Answer: Additives (1) Detergents – To keep engine parts, such as piston and piston rings, clean & free from deposits. (2) Dispersants – To suspend & disperse material that could form varnishes, sludge etc that clog the engine. (3) Anti – wear – To give added strength & prevent wear of heavily loaded surfaces such as crank shaft rods & main bearings. (4) Corrosion inhibitors – To fight the rust wear caused by acids moisture. Protect vital steel & iron parts from rust & corrosion. (5) Foam inhibitors – control bubble growth, break them up quickly to prevent frothing & allow the oil pump to circulate oil evenly. (6)Viscosity index improver – added to adjust the viscosity of oil. (7) Pour point depressant - improves an oil ability to flow at very low temperature ----------

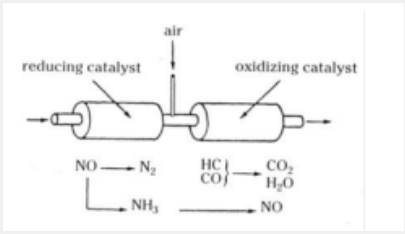
Que.No	Marks	
Q 4a)(a)	4	Question: **Define the following w.r.to. I.C. engine. i) Indicated power ii) Brake power iii) Volumetric efficiency iv) BSFC** Answer: (i) Indicated Power: The total power developed by combustion of fuel in the combustion chamber is called indicated power. (ii) Brake Power: The power developed by an engine at the output shaft is called brake power. (iii) Volumetric efficiency: It is defined as the ratio of the actual volume of the charge admitted into the cylinder to the swept volume of the piston is known as volumetric efficiency. (iv) **Brake specific fuel consumption:** It is the mass of fuel consumed per kw developed per hour, and is a criterion of economical ----------
Q 4a)(b)	4	Question: **Explain the term swept volume (V s) w.r.to. i) I.C. engine ii) Reciprocating air compressor** Answer: (i) Swept Volume (VS) w.r.t I.C.Engine: The volume swept through by the piston in moving between top dead centre and bottom dead centre is called swept volume or piston displacement. It is denoted by VS. It is equal to the area of the piston multiplied by its stroke length. Therefore, Swept Volume = π/4xD2 xL Where D = bore of the cylinder in m, and L = stroke length in m. (ii) Swept Volume (VS) w.r.t. Reciprocating air compressor: It is the actual volume of air taken in during suction stroke. It is expressed in m3 . Swept volume when expressed in m3 /min, it is known as piston displacement. ----------

Que.No	Marks	
Q 4b)(a)	6	Question: **What is meant by catalytic converter ? Briefly explain with the help of neat sketch.** Answer: **Catalytic converter:**  Catalytic converter is a device which converts harmful pollutants to harmless gases. Catalytic converter is used in exhaust emission in control system to convert CO, NOx, HC and other harmful gases to harmless gases. A Catalytic converter consists of a cylindrical unit of small size like a small silencer and is installed into the exhaust system of a vehicle. It is placed between the exhaust manifold and the silencer. Inside the cylindrical tube i.e. converter there is a honey comb structure of a ‘ceramic or metal’ which is coated with ‘alumina base’ material and there after a second coating of precious metals ‘platinum, palladium or rhodium’ or combination of the same. This second coating serves as a catalyst. A catalyst is a substance which causes a chemical reaction intro the gases. When the exhaust gases pass over the converter substance, the toxic gases as CO, HC & NOx are converted into harmless gases as CO2, H2 & N2. ----------

Que.No	Marks	
Q 5 c)	8	Question: **List out different pollutants in exhaust gases of petrol and diesel engine ? Briefly explain theireffects on human beings and environments (atleast four).** Answer: The major air pollutants emitted by petrol & diesel engines are CO2, CO, HC, NOx, SO2, smoke & lead vapour. **Effect of CO:** Carbon monoxide combines with hemoglobin forming carboy hemoglobin ,which reduces oxygen carrying capacity of blood. This leads to laziness, exhaustion of body & headache. Prolong exposure can even leads to death. It also affects cardiovascular system, thereby causing heart problem Effect of CO2: Causes respiratory disorder & suffocation. **Effect of NOx:** It causes respiration irritation, headache, bronchitis, pulmonary emphysema, impairment of lungs, and loss of appetite & corrosion of teeth to human body. **Effect of HC:** • It has effect like reduced visibility, eye irritation, peculiar odour & damage to vegetation & acceleration the cracking of rubber products. • It induce cancer, affect DNA & cell growth are know a carcinogens. **Effect of SO2:** It is toxic & corrosive gas, human respiratory track of animals, plants & crops. ----------

Examination: 2016 SUMMER

Que.No	Marks	
Q 1b)(a)	6	Question: **Explain in brief, how 'Morse test' is carried out ?** Answer: First engine is allowed to run at constant speed and brake power of engine is measured when all four cylinder working. (IP1 + IP2 + IP3 + IP4) = (BP) 1234 + (FP) 1234 Where, IP- indicated power. BP – brake power develop. FP – frictional power. I, 2, 3, 4 – cylinder number respectively. Now the first cylinder is cut off by short circuiting spark plug in case of S.I engine and by cutting fuel supply in case of C.I engine. Due to this, cylinder 1 will not develop IP_1 but continue to consume FP to measure $BP_{(234)}$.reduce speed to bring to initial speed by reducing load. $(IP_2 + IP_3 + IP_4) = (BP)_{234} + FP_{(1234)}$ …… (2) When cylinder 2 is cut off and speed of engine returned to initial speed and to measure $BP_{(134)}$ $(IP_1 + IP_3 + IP_4) = (BP)_{134} + FP_{(1234)}$ …… (3) When cylinder 3 is cut off and speed of engine returned to initial speed and to measure $BP_{(124)}$ $(IP_1 + IP_2 + IP_4) = (BP)_{124} + FP_{(1234)}$ …… (4) When cylinder 4 is cut off and speed of engine returned to initial speed and to measure $BP_{(123)}$ $(IP_1 + IP_2 + IP_3) = (BP)_{123} + FP_{(1234)}$ …… (5) Each cylinder of IP will get by, i) Subtracting equation 2 from equation 1, $IP_1 = BP_{(1234)} - BP_{(234)}$ ii) Subtracting equation 3 from equation 1, $IP_2 = BP_{(1234)} - BP_{(134)}$ iii) Subtracting equation 4 from equation 1, $IP_3 = BP_{(1234)} - BP_{(124)}$ iv) Subtracting equation 5 from equation 1, $IP_4 = BP_{(1234)} - BP_{(123)}$ Thus indicated power of engine $IP = IP_1 + IP_2 + IP_3 + IP_4$ ----------

Que.No	Marks	
Q 1b)(b)	6	Question: **Explain with neat sketch the constructional features of 'Three Way Catalytic Converter'.** Answer:  - Three way convertor uses thin coating of platinum, palladium and rhodium over a support metal (generally alumina) & acts on all three major constituents of exhaust gas pollution i. e. hydrocarbons, carbon monoxide & oxides of nitrogen, oxidizing these to water, carbon dioxide & free hydrogen & nitrogen respectively. - It operates in two stages, the first convertor stage uses rhodium to reduce the NO2 in the exhaust into nitrogen & oxygen. In second stage convertor platinum or palladium acts as oxidation catalyst to change HC & CO into harmless water & CO2. - For supplying the oxygen required in the second stage air is fed into the exhaust after the first stage. - Reactions within catalyst produce additional heat that reaches temperature of 900oC, which is required for the catalytic converter to operate at complete efficiency. To safeguard from this high temperature, the catalytic converter is made of stainless steel &special heat shields are also used. ----------

Que.No	Marks	
Q 2 c)	8	Question: **Following observations were made during a trial on 4-stroke, single cylinder engine running at 240 rpm having brake wheel diameter 1.5 meter. Duration of trial 30 min. Fuel consumption 6 liter C.V. of fuel 42000 kJ/kg Sp. gravity 0.8 IMEP 550 kPa Brake load 150 kg Spring balance reading 15 kg Cylinder diameter 30 cm Stroke length 45 cm Jacket cooling water 11 kg/min Temp. rise in jacket water 36°C Determine : i) I.P. and B.P. ii) Heat balance sheet on percentage basis.** Answer:

Q2 (c) Given,

n = 240 r.p.m. Duration of trial = 30 min.

Fuel consumption = 6 lit

C.V. = 42000 kJ/kg Sp. gravity = 0.8

IMEP = 550 kPa Brake Load = 150 kg

Spring balance reading = 15 kg

d = 30 cm, l = 45 cm, m_w = 11 kg/min

Δt_w = 36°C

$$I.P. = P_m \cdot L \cdot A \cdot \frac{n}{2}$$

$$= 550 \times 10^3 \times 0.45 \times \frac{\pi}{4} \times (0.3)^2 \times \frac{240}{2 \times 60}$$

$$= 35.00 \text{ kW}$$

$$B.P. = 2\pi NT$$

$$= 2\pi \times \frac{240}{60} \times (150 - 15) \times 9.8$$

$$= 33.264 \text{ kW}$$

Heat Supplied = $m_f \times C.V.$ = $\frac{6}{30} \times 0.8 \times 42000$

= 6720 kJ/min (100%)

B.P. = 33.264 × 60

= 1996 kJ/min (29.7%)

Heat lost to cooling water = $m_w \times C_{pw} \times \Delta t_w$

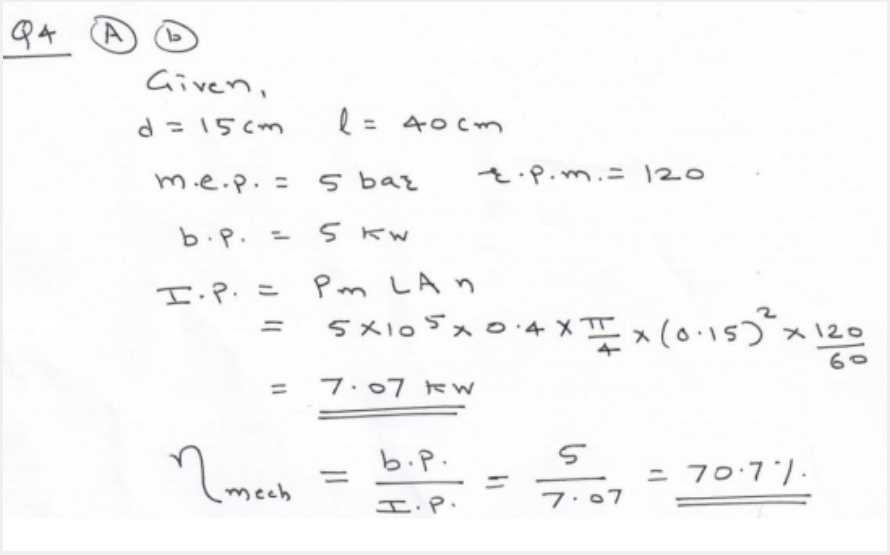
= 11 × 4.187 × 36

= 1658 kJ/min (24.7)

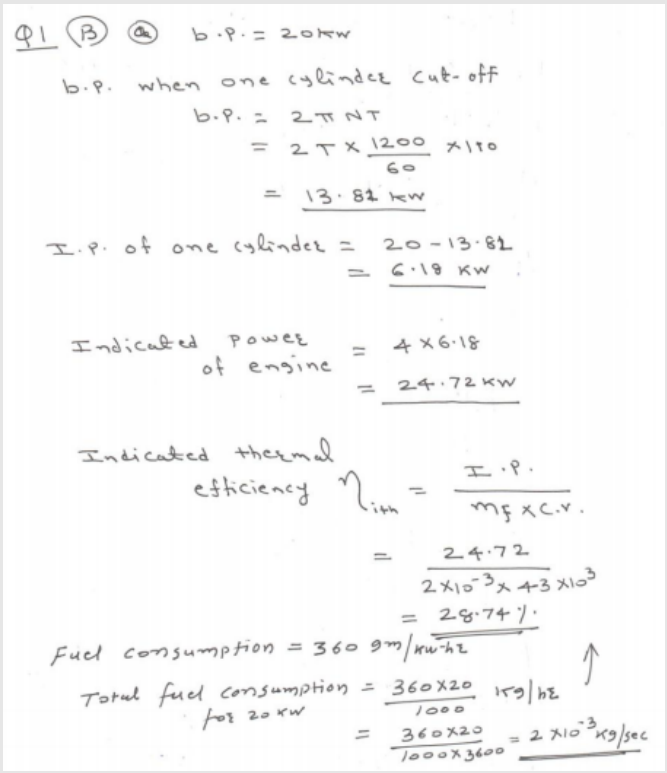
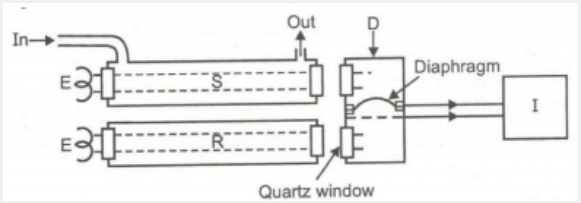
Heat unaccounted = 6720 − (1996 + 1658)

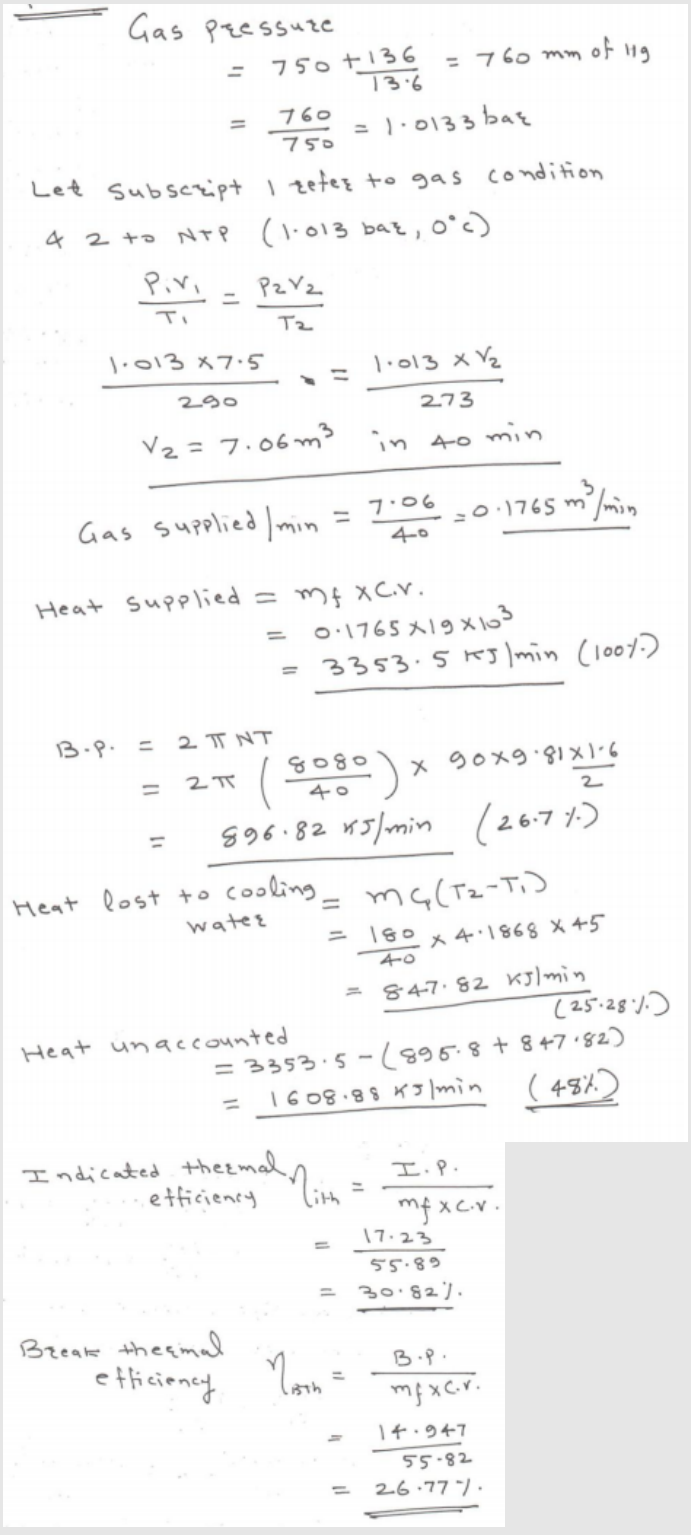
= 3066 kJ/min (45.6 %)

Heat supplied KJ/min	kJ/ min	%	Heat expenditure	kJ/min	Percentage
Heat supplied by combustion of fuel	6720	100	1) Heat equivalent of brake power	1996	29.7%
			2) heat lost to jacket cooling water	1658	24.7%
			3)heat unaccounted	3066	45.6%
TOTAL	3684	100%	TOTAL	3684	100%

Que.No	Marks	
Q 4a)(b)	4	Question: **An engine has piston diameter 15 cm, length of stroke 40 cm and mean effective pressure 5 bar. Engine makes 120 power strokes per minute. Find mechanical efficiency if brake power is 5 kW.** Answer:  Q4 (A) (b) Given, $d = 15\,cm \quad l = 40\,cm$ $m.e.p. = 5\,bar \quad r.p.m. = 120$ $b.p. = 5\,kW$ $I.p. = p_m L A n$ $= 5 \times 10^5 \times 0.4 \times \frac{\pi}{4} \times (0.15)^2 \times \frac{120}{60}$ $= 7.07\,kW$ $\eta_{mech} = \frac{b.p.}{I.p.} = \frac{5}{7.07} = 70.7\%$ ----------
Q 4a)(d)	4	Question: **Explain the term w.r.t. I.C. engine. i) Mean Effective Pressure (MEP) ii) Cut off ratio.** Answer: **(i) Mean effective pressure** – Defined as the average pressure acting on the piston which will produce the same output as is done by the varying pressure during the cycle. **(ii) Cut off ratio** – Fuel is injected into combustion chamber where only air compressed and is at high temperature. Fuel is injected for a duration of time, say T. The piston would not have reached the bottom dead centre in time T. The fuel is cut off when the volume is, say V2. The clearance volume is V1. The ratio V2/V1 is cut off ratio. ----------
Q 4b)(a)	6	Question: **Name any four additives used in lubricants ? State their advantages** Answer: (1) Detergents – To keep engine parts, such as piston and piston rings, clean & free from deposits. (2) Dispersants – To suspend & disperse material that could form varnishes, sludge etc that clog the engine. (3) Anti – wear – To give added strength & prevent wear of heavily loaded surfaces such as crank shaft rods & main bearings. (4) Corrosion inhibitors – To fight the rust wear caused by acids moisture. Protect vital steel & iron parts from rust & corrosion. (5) Foam inhibitors – control bubble growth, break them up quickly to prevent frothing & allow the oil pump to circulate oil evenly. (6)Viscosity index improver – added to adjust the viscosity of oil. (7) Pour point depressant - improves an oil ability to flow at very low temperature. ----------

Examination: 2016 WINTER

Que.No	Marks	
Q 1b)(a)	6	Question: **A four cylinder engine running at 1200 rpm delivers 20 kW. The average torque when one cylinder was cut is 110 N.m. Find the indicated thermal efficiency if the calorific value of the fuel is 43 MJ/Kg and the engine uses 360 gm. of gasoline (fuel) per kW. hr.** Answer:  Q1 (B) (a) b.p. = 20kw b.p. when one cylinder cut-off b.p. = $2\pi NT$ $= 2\pi \times \frac{1200}{60} \times 110$ $= 13.82$ kw I.p. of one cylinder = $20 - 13.82$ $= 6.18$ kw Indicated power of engine = 4×6.18 $= 24.72$ kw Indicated thermal efficiency $\eta_{ith} = \frac{I.p.}{m_f \times C.V.}$ $= \frac{24.72}{2\times10^{-3}\times43\times10^{3}}$ $= 28.74\%$ Fuel consumption = 360 gm/kw-hr Total fuel consumption for 20 kw = $\frac{360\times20}{1000}$ kg/hr $= \frac{360\times20}{1000\times3600} = 2\times10^{-3}$ kg/sec ----------
Q 1b)(b)	6	Question: **Explain with neat sketch working of non dispersive infra red (NDIR) gas analyser.** Answer: Non dispersive infra red gas analyzer (NDIR) : The working principle of infra red gas exhaust gas analyzer is as shown in figure . It works on the principle of hetero atomic gases absorbs infra red energy at distinct and separated wavelength. The absorbed energy raises the temperature and pressure of confined gas. This enables to measure contents of hydro carbon and carbon monoxide. This is a faster method of gas analysis. The standard sample is filled in reference cell R . the sample of gas under testing is filled in cell S . The detector cell D is filled with specific gas to be measured, say CO2 . the detector cell is divided into two compartments by diaphragm. It is very sensitive. Initially infra red energy in both compartment is same and indicator reading is zero. The sample is connected to exhaust gas. This lowers pressure on sample side. It will absorb energy in proportion to concentration of CO2 in sample and detector gives percentage of CO2 present in the samp0le.  ----------

Que.No	Marks	
Q 2 c)	8	Question: **A four stroke gas engine has a cylinder diameter of 25 cm and stroke 45 cm. The effective diameter of brake is 1.6 m. The observations made in a test of the engine were as follows. Duration of test = 40 min. Total no. of revolutions = 8080 Total no. of explosions = 3230 Net load on brake = 90 kg Mean effective pressure = 5.8 bar Volume of gas used = 7.5 m3 Pressure of gas = 136 mm of water Atm. temp. = 17°C Calorific value of gas = 19 MJ/m3 at NTP Rise in temp. of jacket cooling water = 45°C Cooling water supplied = 180 kg Draw heat balance sheet and estimate indicated thermal efficiency and brake thermal efficiency. Assume atmospheric pr. as 760 mm of Hg.** Answer:  Gas pressure $= 750 + \frac{136}{13.6} = 760$ mm of Hg $= \frac{760}{750} = 1.0133$ bar Let Subscript 1 refer to gas condition & 2 to NTP (1.013 bar, 0°C) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\frac{1.013 \times 7.5}{290} = \frac{1.013 \times V_2}{273}$ $V_2 = 7.06\ m^3$ in 40 min Gas supplied/min $= \frac{7.06}{40} = 0.1765\ m^3/min$ Heat supplied $= m_f \times C.V.$ $= 0.1765 \times 19 \times 10^3$ $= 3353.5$ KJ/min (100%) B.P. $= 2\pi NT$ $= 2\pi \left(\frac{8080}{40}\right) \times 90 \times 9.81 \times \frac{1.6}{2}$ $= 896.82$ KJ/min (26.7%) Heat lost to cooling water $= mC_p(T_2 - T_1)$ $= \frac{180}{40} \times 4.1868 \times 45$ $= 847.82$ KJ/min (25.28%) Heat unaccounted $= 3353.5 - (895.8 + 847.82)$ $= 1608.88$ KJ/min (48%) Indicated thermal efficiency $\eta_{ith} = \frac{I.P.}{m_f \times C.V.}$ $= \frac{17.23}{55.89}$ $= 30.82\%$ Break thermal efficiency $\eta_{bth} = \frac{B.P.}{m_f \times C.V.}$ $= \frac{14.947}{55.82}$ $= 26.77\%$

Que.No	Marks	
Q 3 a)	4	Question: **List any four pollutants in exhaust gases of I.C. engine with their effects.** Answer: The major air pollutants emitted by petrol & diesel engines are CO2, CO, HC, NOx, SO2, smoke & lead vapour. Effect of CO: Carbon monoxide combines with hemoglobin forming carboy hemoglobin ,which reduces oxygen carrying capacity of blood. This leads to laziness, exhaustion of body & headache. Prolong exposure can even leads to death. It also affects cardiovascular system, thereby causing heart problem Effect of CO2: Causes respiratory disorder & suffocation. Effect of NOx: It causes respiration irritation, headache, bronchitis, pulmonary emphysema, impairment of lungs, and loss of appetite & corrosion of teeth to human body. Effect of HC: • It has effect like reduced visibility, eye irritation, peculiar odour & damage to vegetation & acceleration the cracking of rubber products. • It induce cancer, affect DNA & cell growth are know a carcinogens. Effect of SO2: It is toxic & corrosive gas, human respiratory track of animals, plants & crops. ----------
Q 4a)(c)	4	Question: **State the norms of Bharat stage III and IV** Answer: Bharat stage III and IV norms : Petrol Emission Norms (All figures in g/km) Emission Norm CO HC NOx HC+NOx PM BS-III 2.30 0.20 0.15 --- --- BS-IV 1.00 0.10 0.08 --- --- Diesel Emission Norms (All figures in g/km) Emission Norm CO HC NOx HC+NOx PM BS-III 0.64 --- 0.50 0.56 0.05 BS-IV 0.50 --- 0.25 0.30 0.025 CO emissions are Carbon Monoxide emissions are are more evident in Petrol engines. Long Term exposure can prevent oxygen transfer and increase headaches/nausea. HC emissions are Hydrocarbons which are again more prevalent in Petrol engines. Short term exposure can cause headaches, vomiting and disorientation. NOx emissions are Nitrogen Oxide emissions which are more prevalent in Diesel engines. Long Term exposure can cause Nose and eye irritation and damage lung tissue. PM is Particulate matter, again more prevalent in a Diesel engine. Long Term exposure can harm the respiratory tract and reduce lung function. ----------
Q 4b)(a)	6	Question: **Define – (i) Indicated power, (ii) Mechanical efficiency, (iii) BSFC** Answer: i) Indicated Power (ip) is defined as the power developed by combustion of fuel in the cylinder of engine. It is always more than brake power. ii) Mechanical efficiency : ηm : It is a measure of mechanical perfection of the engine or its ability to transmit power developed in the engine cylinder to the crank shaft . It is defined as the ratio of brake power to indicated power of the engine iii) **B.S.F.C:** It is the weight of fuel required to develop 1KW of the brake power for period of 1 hour. Unit of B.S.F.C is Kg/KW h. It is defined as the amount of fuel consumed per unit of break power developed per hour. $\text{B.S.F.C} = \frac{fuel\ consumption\ in\ Kg/hr}{Brake\ power\ in\ KW}$ ----------

Que.No	Marks	
Q 4b)(b)	6	Question: **List the additives of lubricant used in S.I engine and state their advantages.** Answer: Additives (any six) (1) Detergents – To keep engine parts, such as piston and piston rings, clean & free from deposits. (2) Dispersants – To suspend & disperse material that could form varnishes, sludge etc that clog the engine. (3) Anti – wear – To give added strength & prevent wear of heavily loaded surfaces such as crank shaft rods & main bearings. (4) Corrosion inhibitors – To fight the rust wear caused by acids moisture. Protect vital steel & iron parts from rust & corrosion. (5) Foam inhibitors – control bubble growth, break them up quickly to prevent frothing & allow the oil pump to circulate oil evenly. (6)Viscosity index improver – added to adjust the viscosity of oil. (7) Pour point depressant - improves an oil ability to flow at very low temperature ----------

Examination: 2015 SUMMER

Que.No	Marks	
Q 1b)(a)	6	Question: **What is the necessity of I.C. Engine Testing ? What are the different test carried out on I.C. Engines ?** Answer: Necessity of I.C. engine testing i) To get information, that is not possible to be determine by calculations. ii) To confirm the validity of data used while designing the engine. iii) To satisfy the customer as to rated power with guarantied fuel consumption. iv) To reduce the cost and to improve the power output and reliability of an engine. v) To know & improve the performance of an engine. Test carried out on I.C. Engine – 1) Commercial Tests 2) Thermodynamic Tests 1) Commercial Tests – These tests are carried out in order to check following a) Rated power out-put with guarantied fuel consumption in kg/kw hr b) Quantity of lubricating oil per kw-hr c) Quantity of cooling water per kw-hr d) Steadiness of engine under varied load conditions e) Overload carrying capacity of the engine 2) Thermodynamic Tests – These tests are carried out for the purpose of comparing actual results with theoretical results by measuring following parameters and then drawing heat balance sheet. i) Indicated power ii) Brake power iii) Frictional power iv) Rate of fuel consumption v) Rate of flow of cooling water and its temperature rise vi) Heat carried by exhaust gas ----------

Que.No	Marks	
Q 1b)(b)	6	Question: **Explain the procedure for conducting Morse test.** Answer: **b)** Morse Test – This test carried out for multi cylinder I.C. engine. In this test, first engine is allowed to run (4-cylinder I.C. engine) at constant speed and brake power of engine is measured when all four cylinders are working and developing indicated power. $\therefore I_2+I_3+I_4 = (BP)_{engine} + (F_1+F_2+F_3+F_4)$ Where I_1, I_2, I_3 and I_4 – Indicated power of four cylinders $(BP)_{engine}$ – Brake power of engine when all cylinders are working F_1, F_2, F_3, F_4 – Frictional power of all four cylinders The first cylinder is cut off by short circuiting in case S.I. engine or cutting fuel supply in case C.I. engine. This causes the speed to drop due to non working of first cylinder and consumption of frictional power. This speed is once again maintained to its original value by reducing load on the engine $\therefore I_2+I_2+I_3+I_4 = (BP)_{2,3,4} + (F_1+F_2+F_3+F_4)$ Where $(BP)_{2,3,4}$ – Brake power of 2,3 & 4 cylinders only. Repeat the above procedure for remaining cylinders and calculate I.P. of the engine. • Cylinder 2 is cut off – $I_1+I_3+I_4 = (BP)_{1,3,4} + (F_1+F_2+F_3+F_4)$ • Cylinder 3 is cut off – $I_1+I_2+I_4 = (BP)_{1,2,4} + (F_1+F_2+F_3+F_4)$ • Cylinder 4 is cut off – $I_1+I_2+I_3 = (BP)_{1,2,3} + (F_1+F_2+F_3+F_4)$ $\therefore$ I.P. of cylinder 1 is calculated as Eq. 1 – Eq.2 $I_1 = (BP)_{engine} - (BP)_{2,3,4}$ Similarly I_2,I_3 and I_4 is calculated as follows $I_2 = (BP)_{engine} - (BP)_{1,3,4}$ $I_3 = (BP)_{engine} - (BP)_{1,2,4}$ $I_4 = (BP)_{engine} - (BP)_{1,2,3}$ $\therefore$ Indicated power of engine = I.P. $IP = I_1+I_2+I_3+I_4$ $\therefore$ Frictional power of engine $FP = IP - (BP)_{engine}$ and mechanical efficiency $\eta_{Mech} = (BP)_{engine}$ Thus Morse test is used to calculate IP, FP and η_{Mech} by assuming FP of each cylinder remains constant. ----------

Que.No	Marks	
Q 2 a)	8	Question: **An I.C. Engine uses 6 kg of fuel having calorific value 44000 kJ/kg in one hour. The IP developed is 18 kW. The temperature of 11.5 kg of cooling water was found to rise through 25°C per minute. The temperature of 42 kg of exhaust gas with specific heat 1 kJ/kg°k was found to rise through 220°C. Draw the heat balance sheet for the engine.** Answer:

a) Mass flow rate of fuel = m = 6 kg/hr

$$mf = \frac{6}{60} = 0.1 kg/min$$

C.V. of fuel = 44,000 kJ/kg

Mass flow rate of cooling water = m_w

m_w = 11.5 Kg/min

$\Delta tw = 25^0 c$

Mass flow rate of exhaust gases = m_g

m_g = 4.2 Kg/min

$\Delta tg = 220^0 c$

Sp. Heat of exhaust gas – 1 kJ/kg^{0}k

Heat supplied by fuel = m_f x C.V. of fuel

= 0.1 x 44,000

= 4,400 kJ/min

Heat equivalent of BP = 18 x 60 = 1080 kJ/min

Heat carried by cooling water

= m_w x Cp_w x Δtw

= 11.5 x 4.187 x 25

= 1203.76 kJ/min

Heat carried by exhaust gas = mg x Cp_g x Δtg

= 4.2 x 1 x 220

= 924 kJ/min

Unaccounted heat =

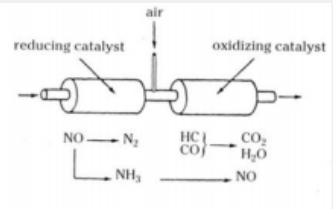
Heat supplied – (Heat equivalent of BP + Heat carried by cooling water + Heat carried by exhaust. gas)

= 4400 – (1080 + 1203.76 + 924)

= 1192.24 kJ/min

Heat balance sheet

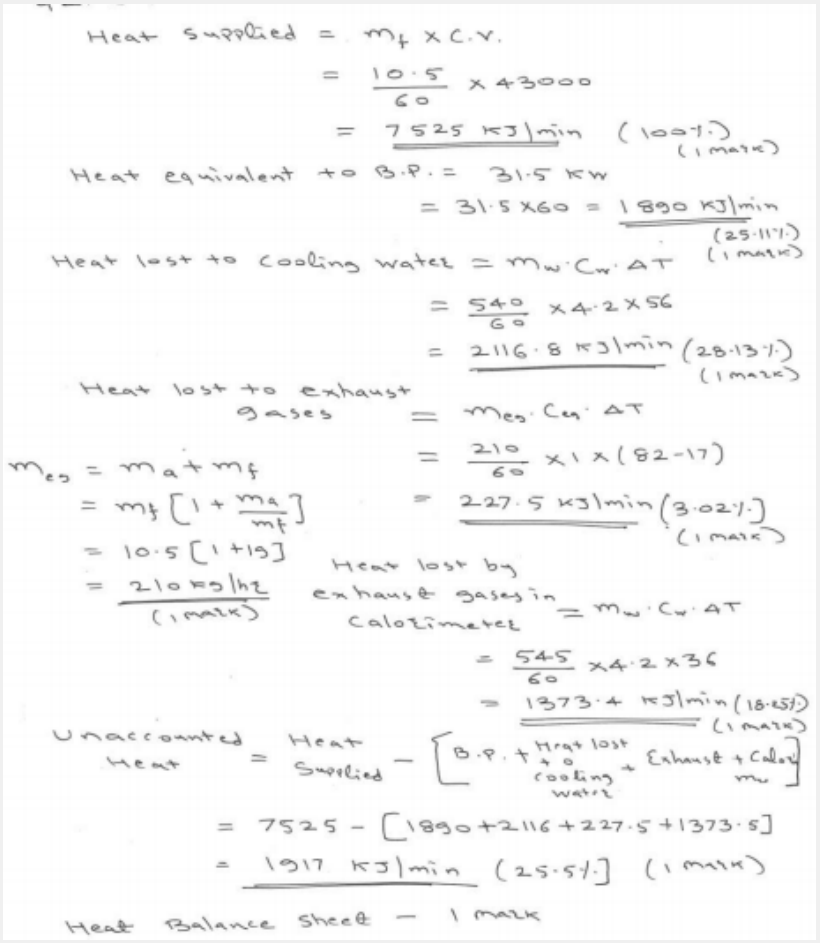
Heat supplied	kJ/min	%	Heat expenditure	kJ/min	%
Heat supplied by fuel	4400	100	Heat equivalent BP	1080	24.54
			heat in C.W.	1203.76	27.36
			Heat in exh. gas	924	21.00
			uncounted heat	1192.24	27.10
	4400	100		4400	100

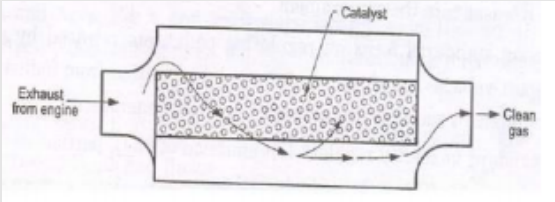
Que.No	Marks	
Q 3 c)	4	Question: **Explain three way catalytic convertor.** Answer:  - Three way convertor uses thin coating of platinum , palladium and rhodium over a support metal (generally alumina) & acts on all three major constituents of exhaust gas pollution i. e. hydrocarbons, carbon monoxide & oxides of nitrogen, oxidizing these to water , carbon dioxide & free hydrogen & nitrogen respectively. - It operates in two stages, the first convertor stage uses rhodium to reduce the NO_2 in the exhaust into nitrogen & oxygen. In second stage convertor platinum or palladium acts as oxidation catalyst to change HC & CO into harmless water & CO_2. - For supplying the oxygen required in the second stage air is fed into the exhaust after the first stage. - Reactions within catalyst produce additional heat that reaches temperature of 900°C, which is required for the catalytic converter to operate at complete efficiency. To safeguard from this high temperature, the catalytic converter is made of stainless steel &special heat shields are also used. ----------
Q 4 b)	4	Question: **What are the effects of pollutants on environment ?** Answer: The major air pollutants emitted by petrol & diesel engines are CO2, CO, HC, NOx, SO2, smoke & lead vapour. Effect of CO: (1) Carbon monoxide combines with hemoglobin forming carboy hemoglobin ,which reduces oxygen carrying capacity of blood. (2) This leads to laziness, exhaustion of body & headache. (3) Prolong exposure can even leads to death. (4) It also affects cardiovascular system, thereby causing heart problem Effect of CO2: Causes respiratory disorder & suffocation. Effect of NOx: • It causes respiration irritation, headache, bronchitis, pulmonary emphysema, impairment of lung, loss of appetite , & corrosion of teeth to human body. Effect of HC: • It has effect like reduced visibility, eye irritation , peculiar odour & damage to vegetation & acceleration the cracking of rubber products. • It induce cancer, affect DNA & cell growth are know a carcinogens. Effect of SO2: It is toxic & corrosive gas, human respiratory track of animals, plants & crops ----------

Que.No	Marks	
Q 4b)(b)	6	Question: **The following results were obtained during Morse test on 4-stroke petrol engine. B.P. developed when all cylinders are working = 16.2 kW. B.P. developed when cylinder No. 1 cutt off = 11.55 kW. B.P. developed when cylinder No. 2 cut off = 11.63 kW B.P. developed when cylinder No. 3 cut off = 11.68 kW B.P. developed when cylinder No. 4 cut off = 11.51 kW Calculate mechanical efficiency of engine.** Answer: $(B.P.)_{engine} = 16.2$ kW ,$(B.P.)_{2,3,4} = 11.55$ kW, $(B.P.)_{1,3,4} = 11.63$ kW, $(B.P.)_{1,2,4} = 11.68$ kW $(B.P.)_{1,2,3} = 11.51$ kW I.P. of 1st cylinder = $I_1 = (B.P.)_{engine} - (B.P.)_{2,3,4} = 16.2 - 11.55 = 4.65$ kW Similarly, $I_2 = (B.P.)_{engine} - (B.P.)_{1,3,4} = 16.2 - 11.63 = 4.57$ kW $I_3 = (B.P.)_{engine} - (B.P.)_{1,2,4} = 16.2 - 11.68 = 4.52$ kW $I_4 = (B.P.)_{engine} - (B.P.)_{1,2,3} = 16.2 - 11.51 = 4.69$ kW Indicated power of engine I.P. = $I_1 + I_2 + I_3 + I_4 = 4.65 + 4.57 + 4.52 + 4.69 = 18.43$ kW $Mechanical\ efficiency = \frac{B.P.}{I.P.} * 100$ $Mechanical\ efficiency = \frac{16.2}{18.43} * 100$ **Mechanical efficiency = 87.9 %** ----------Ans ----------

Examination: 2015 WINTER

Que.No	Marks	
Q 1b)(b)	6	Question: **Write any three pollutants in exhaust gasses of petrol and diesel engine with their effects on environment.** Answer: The major air pollutants emitted by petrol & diesel engines are CO2, CO, HC, NOx, SO2, smoke & lead vapour. Effect of CO: Carbon monoxide combines with hemoglobin forming carboy hemoglobin ,which reduces oxygen carrying capacity of blood. This leads to laziness, exhaustion of body & headache. Prolong exposure can even leads to death. It also affects cardiovascular system, thereby causing heart problem Effect of CO2: Causes respiratory disorder & suffocation. Effect of NOx: It causes respiration irritation, headache, bronchitis, pulmonary emphysema, impairment of lungs, and loss of appetite & corrosion of teeth to human body. Effect of HC: • It has effect like reduced visibility, eye irritation, peculiar odour & damage to vegetation & acceleration the cracking of rubber products. • It induce cancer, affect DNA & cell growth are know a carcinogens. Effect of SO2: It is toxic & corrosive gas, human respiratory track of animals, plants & crops ----------

Que.No	Marks	
Q 2 c)	8	Question: **The following observations were made during the test on an oil engine BP of engine = 31.5 kW, fuel used = 10.5 kg/hr, C.V. of fuel = 43,000 kJ/kg, jacket circulating water = 540 kg/hr, rise in temperature of cooling water = 56°C, water circulated through exhaust gas calorimeter = 545 kg/hr, rise in temperature of water passing through exhaust gas calorimeter = 36°C, temperature of exhaust gas leaving the exhaust gas calorimeter = 82°C, A : F ratio = 19:1, ambient temperature = 17°C, Cp for exhaust gases = 1 kJ/kg°k. Draw up the heat balance sheet on minute basis.** Answer:  Heat Supplied = $m_f \times C.V.$ $= \frac{10.5}{60} \times 43000$ $= 7525$ kJ/min (100%) (1 mark) Heat equivalent to B.P. = 31.5 kW $= 31.5 \times 60 = 1890$ kJ/min (25.11%) (1 mark) Heat lost to cooling water $= m_w \cdot C_w \cdot \Delta T$ $= \frac{540}{60} \times 4.2 \times 56$ $= 2116.8$ kJ/min (28.13%) (1 mark) Heat lost to exhaust gases $= m_{eg} \cdot C_{eg} \cdot \Delta T$ $= \frac{210}{60} \times 1 \times (82-17)$ $= 227.5$ kJ/min (3.02%) (1 mark) $m_{eg} = m_a + m_f$ $= m_f \left[1 + \frac{m_a}{m_f}\right]$ $= 10.5 [1+19]$ $= 210$ kg/hr (1 mark) Heat lost by exhaust gases in Calorimeter $= m_w \cdot C_w \cdot \Delta T$ $= \frac{545}{60} \times 4.2 \times 36$ $= 1373.4$ kJ/min (18.25%) (1 mark) Unaccounted Heat = Heat Supplied − [B.P. + Heat lost to cooling water + Exhaust + Calori mv] $= 7525 - [1890 + 2116 + 227.5 + 1373.5]$ $= 1917$ kJ/min (25.5%) (1 mark) Heat Balance Sheet — 1 mark ----------

Que.No	Marks	
Q 3 a)	4	Question: **What is catalytic convertor ? Explain two way catalytic convertor with neat sketch** Answer:  Catalytic converter is a device which converts harmful pollutants to harmless gases. Catalytic converter is used in exhaust emission in control system to convert CO, NOx, HC and other harmful gases to harmless gases. A Catalytic converter consists of a cylindrical unit of small size like a small silencer and is installed into the exhaust system of a vehicle. It is placed between the exhaust manifold and the silencer. Inside the cylindrical tube i.e. converter there is a honey comb structure of a ‘ceramic or metal’ which is coated with ‘alumina base’ material and there after a second coating of precious metals ‘platinum, palladium or rhodium’ or combination of the same. This second coating serves as a catalyst. A catalyst is a substance which causes a chemical reaction intro the gases. When the exhaust gases pass over the converter substance, the toxic gases as CO, HC & NOx are converted into harmless gases as CO2, H2 & N2 ----------

Que.No	Marks	
Q 3a)(d)	4	Question: **Describe the method to measure indicated power of I.C. engine.** Answer: **Method to measure Indicated power :**

Indicated Power :

The power developed inside the engine cylinder is known as indicated power and denoted by I.P.

Measurement of indicated power :

Indicated power of engine at a particular speed can be calculated with the help of indicator. The indicator is fitted to the engine cylinder.

The strength of the spring to be used in the indicator must be carefully chosen.

The ratio of maximum pressure in the engine cylinder to the mean pressure during the cycle in an I.C. engine is much greater than that of any other heat engine.

The variation of pressure inside the engine cylinder is obtained an a diagram called as indicator diagram as shown in Fig.

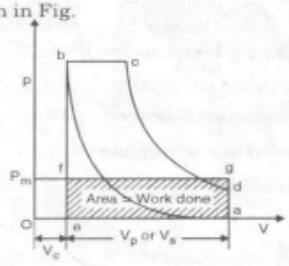


Fig. 2.1

The diagram obtained is a curved abcd the area under the curve is workdone as shown in P-V diagram work obtained = A (a – b – c – d).

Area (a b c d) into rectangle of length equal to stroke volume as shown in Fig. 2.1.

$$A\,(a-b-c-d) = A\,(a-e-f-g)$$

Consider height of rectangle as mean effective pressure (P_m)

∴ Average variation of pressure inside engine cylinder equal to P_m

$$\text{work/cycle} = A\,(a-b-c-d) = A\,(a-e-f-g) = P_m V_s$$

$$= P_m A \times L$$

$$= P_m \times \frac{\pi}{4} d^2 L$$

$$\text{Indicated power} = \text{workdone/cycle} \times N$$

$$= P_m A L N$$

Where N is speed of engine then N number of power stroke or explosion.

a) For two stroke engine

$$I.P. = P_m A L N$$

b) For four stroke engine

$$I.P. = P_m A L \times \frac{N}{2}$$

$$N = \frac{N}{2}$$

because one power stroke is completed in two revolution of crankshaft. Indicated mean effective pressure can be calculated as,

$$P_m = \frac{\text{Area of indicator diagram} \times \text{spring index}}{\text{length of indicator diagram}}$$

$$= \frac{a \times s}{l}\ N/m^2$$

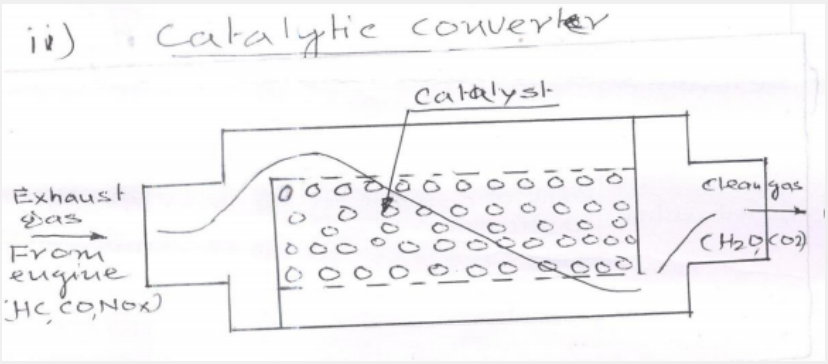
where a = Area of indicator diagram

l = length of indicator diagram

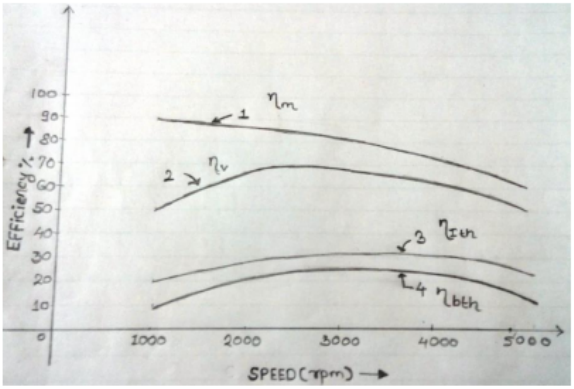
s = spring index in N/m^2 per meter.

Que.No	Marks	
Q 4a)(b)	4	Question: **Define the following related I.C. engine. i) Indicated power ii) Brake power iii) Brake specific fuel consumption iv) Relative efficiency.** Answer: i) Indicated Power (ip) is defined as the power developed by combustion of fuel in the cylinder of engine. It is always more than brake power. ii Brake Power:- □ The useful power which is available at the crank shaft is called as brake power. □ It is denoted by "B.P." □ It has unit kW iii) B.S.F.C: It is the weight of fuel required to develop 1KW of the brake power for period of 1 hour. Unit of B.S.F.C is Kg/KWh. It is defined as the amount of fuel consumed per unit of break power developed per hour. $\text{B.S.F.C} = \frac{fuel\ consumption\ in\ Kg/hr}{Brake\ power\ in\ KW}$ iv) Relative efficiency is defined as the ratio of indicated / brake thermal efficiency to the air standard efficiency. ----------
Q 4b)(a)	6	Question: **List the additives of Lubricant used in S.I. engine and state their advantages.** Answer: Role of following lubricant additives (one mark each) 1. Zinc ditinophosphate: - Zinc ditinophosphate serves as an anti – oxidant and anticorrosive additive. 2. Fatty acids: - This type of additives prevents rusting of ferrous engine parts during and form acidic moisture accumulation during cold engine operation. 3. Organic Acids: - This type of additives improves the detergent action of lubricating oil. 4. Ester: - To lower the pour point of lubricating oil. 5. Silicon polymers: - This additive serves as Antifoam Agent. 6. Butylene polymers: - This type of additives added in lubricating oil to increase their viscosity index. 7. Zinc ditinophosphate: - Zinc ditinophosphate serves as an anti – oxidant and anticorrosive additive. 8. Fatty acids: - This type of additives prevents rusting of ferrous engine parts during and form acidic moisture accumulation during cold engine operation. 9. Organic Acids: - This type of additives improves the detergent action of lubricating oil. 10. Ester: - To lower the pour point of lubricating oil. 11. Silicon polymers: - This additive serves as Antifoam Agent. 12. Butylene polymers: - This type of additives added in lubricating oil to increase their viscosity index. ----------

Examination: 2014 WINTER

Que.No	Marks	
Q 1b)(i)	6	Question: **What do you mean by: 1) frictional power 2) brake thermal efficiency 3) BSFC, w.r.to I.C. engine** Answer: 1) Friction Power:- The difference between indicated power and brake power. It is the power lost in friction FP =IP -BP 2) **Brake Thermal Efficiency**:- $\eta_{bTh} = \frac{Heat\ equivalentto\ brake\ power}{Heat\ Supplied}$ $= \frac{B.P.\ in\ kw}{Mass\ of\ \ fuel\ in\ kg \times C.V.\ in\ \sec.kj/kg}$ 3) BSFC – Brake Specific fuel consumption = *Fuel consumption in kg/hr / Brake power in kw* ----------
Q 1b)(ii)	6	Question: **Explain with neat sketch any one catalytic converter** Answer:  Fig. shows construction of simple catalytic converter exhaust fan as it enters the converter all three pollutions namely HC CO and NOX oxidizes and reduce is to the component which are acceptable to the environment, This occurs due to chemical reaction and at 600 to 7000 c temperature. ----------

Que.No	Marks	
Q 2 c)	8	Question: **During a trial on 4-stroke gas engine following observations were recorded: Bore = 300 mm ; Speed = 200 rpm Stroke = 400 mm ; Gas used = 11.7 m3/h Number of explosions/min = 90 Gauge pressure of gas = 170 mm of water Barometer reading = 755 mm of Hg Mean effective pressure = 6 bar Calorific value of gas used = 21500 KJ/kg at N.T.P. Net load on brake = 2 KN Brake drum diameter = 1.2 m Ambient temperature = 27°C Calculate: (i) mechanical efficiency (ii0 brake thermal efficiency.** Answer: Indicated power – IP = PmepLAN Where Pmep – 6 bar – mean effective pressure - 6 x 100 kN/m2 L – Length of stroke in m $\frac{400}{1000} m$ $0.4m$ A – Area of bore in m² $\pi/4 \times \left(\frac{300}{1000}\right)^2$ $0.07065 m^2$ N – No. of explosion/sec. - 90/60 - 1.5 explosion/sec. ∴ IP = 6 x 100 x 0.4 x 0.07065 x 1.5 IP = 25.434 kw Brake Power = (w-s) π D.N. Where (w-s) – Net load in kN - 2 kN π D – Circumference of brake drum in m - π 1.2 - 3.768 m N – Speed of engine in RPS - 200/60 - 3.333 r.p.s. ∴ Brake Power – BP – 2 x 3.768 x 3.333 BP = 25.117 kW ∴ Mech. Efficiency $\eta_{Mech} = \frac{BP}{IP}$ $\eta_{Mech} = \frac{25.117}{25.434} = 98.75\%$ Pressure of gas supplied $= 755 + \frac{170}{13.6} = 767.5 mm\ of\ Hg$ ∴ volume of gas used at NTP/sec. $= \frac{11.7}{3600} \times \frac{273}{273+27} \times \frac{767.5}{755}$ $= 0.00300 m^3/\text{sec.}$ Assuming CV of gas used as 21,500 kj/m3 at NTP instead of 21,500 kJ/kg at NTH Heat supplied by fuel in kJ/sec. = 0.00300 x 21,500 = 64.5 kJ/sec. ∴ Brake thermal efficiency - $\eta_{B.Th}$ $= \frac{BP\ in\ kw}{Heat\ \text{sup}\ plied\ in\ kJ/\text{sec.}}$ $= \frac{25.117}{64.5} \times 100$ $\eta_{B.Th} = 38.94\%$ ----------

Que.No	Marks	
Q 3 a)	4	Question: **The results of exhaust gas analysis for petrol engine running at full load and at constant speed are shown in Fig. No. 1. Label the exhaust gases (indicated by 1, 2, 3, 4). Which conclusion can be drawn from this figure.** Answer: 1- O_2 2- CO_2 3- CO 4- H_2 As fuel to air ratio increases % of O_2 reduces % of CO_2 increases upto chemically correct mixture and then it decreases % of CO increases beyond chemically correct mixture % of H_2 increases beyond chemically correct mixture ---
Q 4a)(iv)	4	Question: **Various efficiencies of 4-stroke petrol engine run at full throttle over its speed range are plotted in Fig. No. 2. Label different efficiency curves (indicated by 1, 2, 3, 4). Which conclusion can be drawn from this figure.** Answer:  **Curve 1:-** Mechanical efficiency **Curve 2:-** Volumetric efficiency **Curve 3:-** Indicated thermal efficiency. **Curve 4 :-** Brake thermal efficiency ---
Q 4b)(I)	6	Question: **State the role of following lubricant additives: 1) zinc ditinophosphate 2) fatty acids 3) organic acids 4) ester 5) silicone polymers 6) butylene polymers.** Answer: Role of following lubricant additives 1. Zinc ditinophosphate: - Zinc ditinophosphate serves as an anti – oxidant and anticorrosive additive. 2. Fatty acids: - This type of additives prevents rusting of ferrous engine parts during and form acidic moisture accumulation during cold engine operation. 3. Organic Acids: - This type of additives improves the detergent action of lubricating oil. 4. Ester: - To lower the pour point of lubricating oil. 5. Silicon polymers: - This additive serves as Antifoam Agent. 6. Butylene polymers: - This type of additives added in lubricating oil to increase their viscosity index. ---

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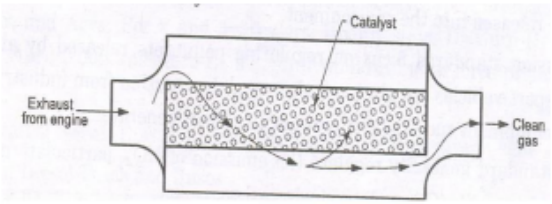
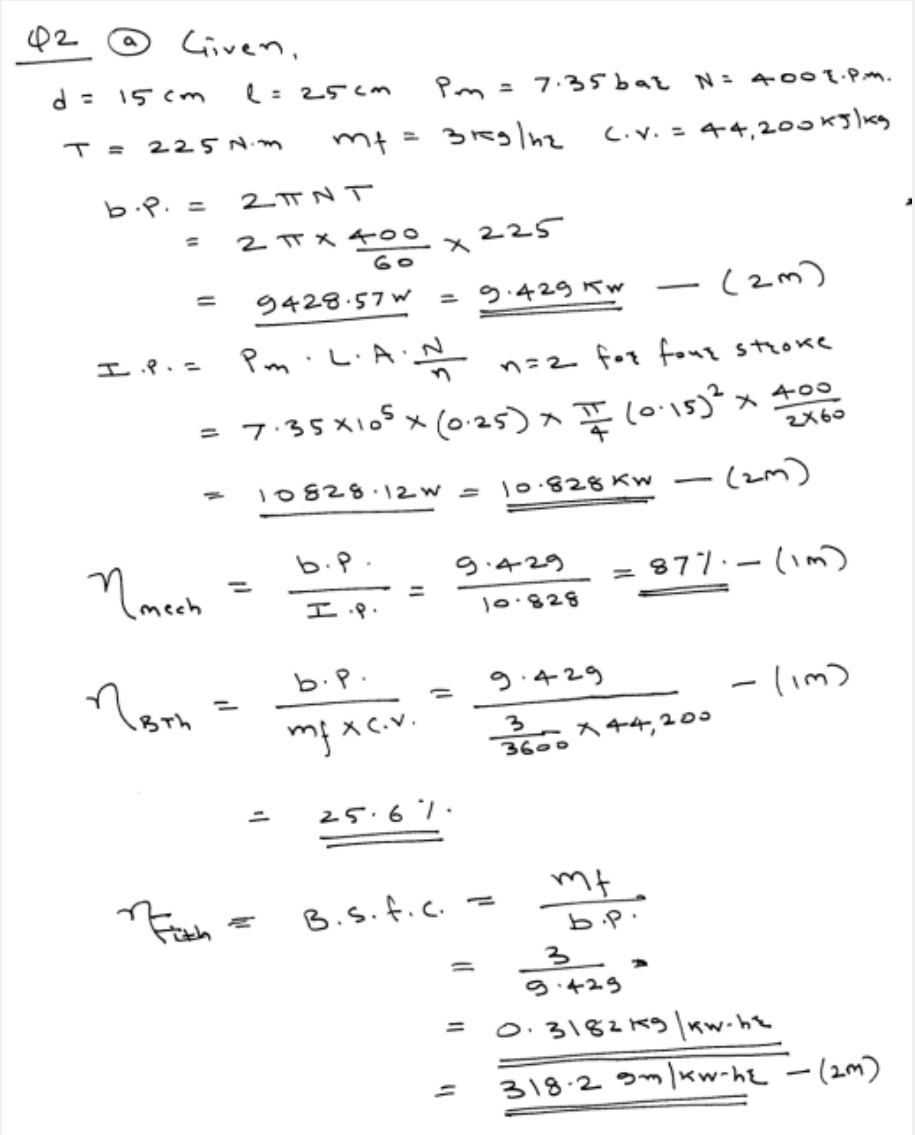
Que.No	Marks	
Q 1b)(a)	6	Question: **State different methods of determining frictional power of I.C. engine and explain any one method** Answer: **Methods to determine the frictional power of I.C. engine are`** 1. Willan's line method 2. Morse test 3. Motoring test 4. Difference between i.p. and b.p. **Explanation of any one method** ---
Q 1b)(b)	6	Question: **Explain with neat sketch working principle of any one type of catalytic converter.** Answer: **Catalytic converter:**  Catalytic converter is a device which converts harmful pollutants to harmless gases. Catalytic converter is used in exhaust emission in control system to convert CO, NO_x, HC and other harmful gases to harmless gases. A Catalytic converter consists of a cylindrical unit of small size like a small silencer and is installed into the exhaust system of a vehicle. It is placed between the exhaust manifold and the silencer. Inside the cylindrical tube i.e. converter there is a honey comb structure of a 'ceramic or metal' which is coated with 'alumina base' material and there after a second coating of precious metals 'platinum, palladium or rhodium' or combination of the same. This second coating serves as a catalyst. A catalyst is a substance which causes a chemical reaction intro the gases. When the exhaust gases pass over the converter substance, the toxic gases as CO, HC & NO_x are converted into harmless gases as CO_2, H_2 & N_2. ---

Que.No	Marks	
Q 1b)(i)	4	Question: **Define : i) Brake thermal efficiency ii) BSFC related to I.C. Engine.** Answer: **i) Brake thermal efficiency** – It is defined as the ratio of heat equivalent to brake power per unit time to the heat supplied to the engine per unit time Brake thermal efficiency = B.P./ mf x C.V. **ii) BSFC** – It is the mass of fuel required to develop 1 kW brake power for a period of one hour. It is inversely proportional to the brake thermal efficiency. BSFC = Mass of fuel consumed in kg/hr / Brake power in kW ----------

Que.No	Marks	
Q 2 a)	8	Question: **Following observations were recorded during a trial on single cylinder four stroke oil engine : Cylinder bore = 15 cm Length of stroke = 25 cm Mean effective pressure = 7.35 bar Engine speed = 400 rpm Brake torque = 225 N.m. Fuel consumption = 3 kg/hr Calorific value of fuel = 44200 kJ/kg. Determine : i) Mechanical efficiency ii) Brake thermal efficiency iii) Brake specific fuel consumption.** Answer:  ----------

Q2 (a) Given,

$d = 15\,cm \quad l = 25\,cm \quad P_m = 7.35\,bar \quad N = 400\,r.p.m.$

$T = 225\,N.m \quad m_f = 3\,kg/hr \quad C.V. = 44,200\,kJ/kg$

$b.p. = 2\pi NT$

$= 2\pi \times \frac{400}{60} \times 225$

$= 9428.57\,W = 9.429\,kW$ — (2m)

$I.p. = P_m \cdot L \cdot A \cdot \frac{N}{n}$ $n = 2$ for four stroke

$= 7.35 \times 10^5 \times (0.25) \times \frac{\pi}{4} (0.15)^2 \times \frac{400}{2 \times 60}$

$= 10828.12\,W = 10.828\,kW$ — (2m)

$\eta_{mech} = \frac{b.p.}{I.p.} = \frac{9.429}{10.828} = 87\%$ — (1m)

$\eta_{BTh} = \frac{b.p.}{m_f \times C.V.} = \frac{9.429}{\frac{3}{3600} \times 44,200}$ — (1m)

$= 25.6\%$

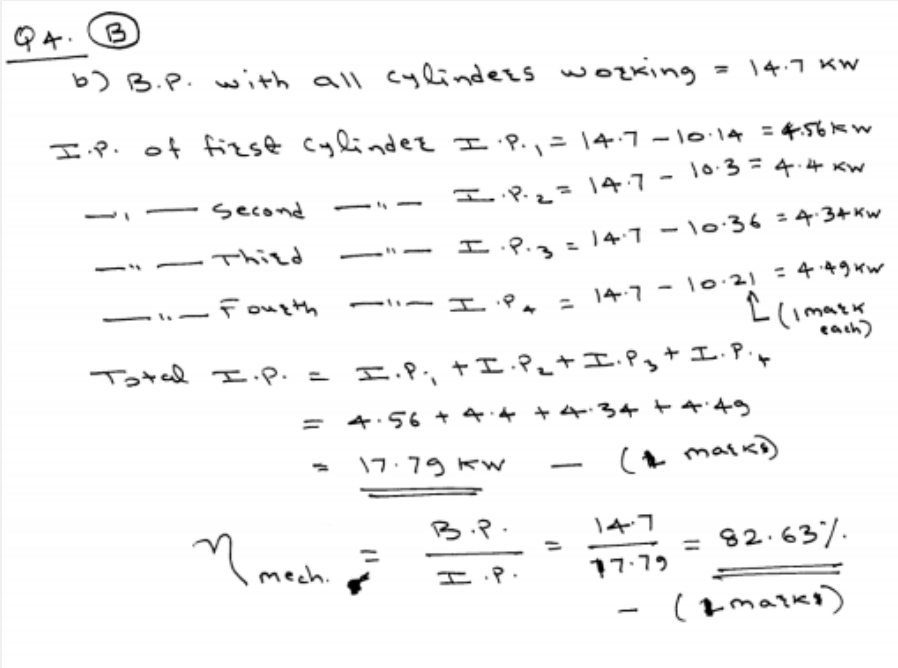
$\eta_{Fuel} \equiv B.S.f.c. = \frac{m_f}{b.p.}$

$= \frac{3}{9.429}$

$= 0.3182\,kg/kw\text{-}hr$

$= 318.2\,gm/kw\text{-}hr$ — (2m)

Que.No	Marks	
Q 3 c)	4	Question: **State effects of pollutants in exhaust gases of petrol engine.** Answer: The major air pollutants emitted by petrol engines are CO2, CO, HC, NOx, SO2, smoke & lead vapour. **Effect of CO:** Carbon monoxide combines with hemoglobin forming carboy hemoglobin, which reduces oxygen carrying capacity of blood. 1. This leads to laziness, exhaustion of body & headache. 2. Prolong exposure can even leads to death. 3. It also affects cardiovascular system, thereby causing heart problem **Effect of CO2:** Causes respiratory disorder & suffocation. **Effect of HC:** 1. It has effect like reduced visibility, eye irritation, peculiar odour & damage to vegetation & acceleration the cracking of rubber products. 2. It induce cancer, affect DNA & cell growth are know a carcinogens. **Effect of SO2**: It is toxic & corrosive gas, human respiratory track of animals, plants & crops. ----------
Q 4a)(b)	4	Question: **Define : i) Mechanical efficiency ii) Volumetric efficiency related to I.C. engine.** Answer: **i) Mechanical Efficiency**- It is the ratio of the power available at the engine crankshaft (bp) to the power developed in the engine cylinder (ip). **ii) Volumetric efficiency** :- It is the ratio of the actual volume of the charge admitted into the cylinder to the swept volume of the piston . ----------
Q 4a)(c)	4	Question: **State advantages of closed cycle gas turbine.** Answer: Advantages of closed cycle gas turbine: (i) It has higher thermal efficiency for the same minimum and maximum temperature limits and for the same pressure ratio. (ii) Since the heating is external, any kind of fuel even solid fuel having low calorific value may be used. (iii) There is no corrosion due to circulation of combustion product. (iv) As the system is a closed one there is no loss of the working fluid. (v) The size of the turbine will be smaller compared to an open cycle gas turbine of the same output. (vi) The regulation is more simple. (vii) The heat transmission coefficient in the exchanger is better due to the increase in suction pressure. (viii) Loss due to fluid friction is less due to higher Reynolds number. ----------

Que.No	Marks	
Q 4b)(b)	6	Question: **The following data is collected during a trial of four stroke four cylinder petrol engine. B.P. with all cylinders working = 14.7 kW B.P. with cylinder no. 1 cut off = 10.14 kW B.P. with cylinder no. 2 cut off = 10.3 kW B.P. with cylinder no. 3 cut off = 10.36 kW B.P. with cylinder no. 4 cut off = 10.21 kW Find mechanical efficiency of engine.** Answer:  Q4. (B) b) B.P. with all cylinders working = 14.7 KW I.P. of first cylinder $I.P._1 = 14.7 - 10.14 = 4.56$ KW — " — Second — " — $I.P._2 = 14.7 - 10.3 = 4.4$ KW — " — Third — " — $I.P._3 = 14.7 - 10.36 = 4.34$ KW — " — Fourth — " — $I.P._4 = 14.7 - 10.21 = 4.49$ KW (1 mark each) Total $I.P. = I.P._1 + I.P._2 + I.P._3 + I.P._4$ $= 4.56 + 4.4 + 4.34 + 4.49$ $= 17.79$ KW — (1 marks) $\eta_{mech.} = \frac{B.P.}{I.P.} = \frac{14.7}{17.79} = 82.63\%$ — (1 marks) ----------

Que.No	Marks	
Q 6 a)	4	Question: **State any four types of sensors used in I.C. engine.** Answer: **Following sensors are used in ECU:** A permanent magnet inductive signal generator is mounted in close proximity to the flywheel, where it radiates a magnetic field. As the flywheel spins and the pins are rotated in the magnetic field, an alternating (AC) waveform is delivered to the ECM to indicate speed of rotation. **Air Flow Sensor (AFS):** The AFS is normally located between the air filter and the throttle body. As air flows through the sensor, it deflects a vane (flap) which wipes a potentiometer resistance track and so varies the resistance of the track and generates a variable voltage signal. Manifold absolute pressure (MAP) sensor: The MAP sensor measures the manifold vacuum or pressure, and uses a transducer to convert the signal to an electrical signal which is returned to the ECM. The unit may be designed as an independent sensor that is located in the engine compartment or integral with the ECM. **Coolant temperature sensor (CTS):** The CTS is a two-wire thermistor that measures the coolant temperature. The CTS is immersed in the engine coolant, and contains a variable resistor that usually operates on the NTC principle. **Throttle Position Sensor (TPS):** TPS is provided to inform the ECM of idle position, deceleration, rate of acceleration and wide-open throttle (WOT) conditions. The TPS is a potentiometer which varies the resistance and voltage of the signal returned to the ECM. **Oxygen sensor (OS)**: An oxygen sensor is a ceramic device 'placed in the exhaust manifold on the engine side of the catalytic converter. The oxygen sensor returns a signal to the ECM, which can almost instantaneously (within 50 ms) adjust the injection duration ----------