PRACTICE QUESTIONS

for SSC-JE : CBT-2

IC Engine

Mechanical Engineering

06

IC Engine

Q.1 In an air standard Otto cycle with n = 1.5, the compression ratio is 8, the compression begins at 40°C and 0.1 MPa. The maximum temperature in the cycle is 1200°C. The heat supplied per kg of air is

(a) 420 kJ/kg (b) 587 kJ/kg
(c) 474 kJ/kg (d) 503 kJ/kg

Q.2 An engine working on Diesel cycle has a pressure and temperature of 1 bar and 17°C at the beginning of compression. The pressure at the end of compression is 35 bar and the expansion ratio is 5. What will be the cut off ratio? [Given $(35)^{0.7} = 12$, $(35)^{0.5} = 5.9$]

(a) 2.4 (b) 2.8
(c) 3.2 (d) 3.6

Q.3 Consider the following statements:

1. Insufficient air causes excess smoke .
2. Exhaust gas with intake air increases NO_x emission.
3. Bomb calorimeter gives HCV of only solid fuel.
4. Abnormal combustion result in knocking of engine.

Which of these statements are in correct?

(a) 1, 2 and 3 (b) 1 and 4
(c) 2, 3 and 4 (d) 2 and 3

Q.4 A single cylinder CI engine has brake thermal efficiency of 35% and mechanical efficiency of 75%. It is supplied with high speed diesel oil of 40 MJ/kg calorific value. What is the indicated specific fuel consumption?

(a) 0.257 kg/kW-hr (b) 0.193 kg/kW-hr
(c) 0.141 kg/kW-hr (d) 0.103 kg/kW-hr

Q.5 The knocking tendency of a diesel engine increases with:

1. increasing the inlet temperature and pressure.
2. decreasing the supercharging of inlet air.
3. decreasing the cooling water jacket temperature.
4. increasing the compression ratio.
5. using lower cetane rating of fuel.

Which of the above statements are correct?

(a) 1 and 4 (b) 1, 2, 4 and 5
(c) 2, 3 and 5 (d) 1, 3 and 5

Q.6 Air standard diesel cycle has a compression ratio of 14 and cut off takes place at 6% of the stroke. What is the cut off ratio?

(a) 1.52 (b) 1.64
(c) 1.78 (d) 1.88

Q.7 Which of the following catalytic converter used for oxides of nitrogen (NO_x)?

(a) Platinum (b) Palladium
(c) Rhodium (d) None of these

Q.8 Consider the following statements:

1. Presence of hot surfaces in the end region of gas.
2. Short ratio of flame path to bore.
3. Smaller bore.

Which of these statements are correct characteristics of combustion chamber for SI engines to avoid knocking?

(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3

Q.9 For a given compression ratio (r) the work output of Otto cycle

(a) Increase with increase in γ
(b) Decrease with increase in γ
(c) Is not affected with change in γ
(d) none of the above

Q.10 A single-cylinder, four stroke diesel engine having a displacement volume of 790 cc is tested at 300 rpm. When a braking torque of 49 N-m is applied, analysis of indicator diagram gives a mean effective pressure of 980 kPa. The mechanical efficiency of the engine is
(a) 90% (b) 80%
(c) 70% (d) 65%

Q.11 A diesel engine is working with a compression ratio of 15 and expansion ratio of 10. (Assume $\gamma = 1.4$)
(a) cut-off ratio = 1.5, clearance ratio = 7.14%, $\eta_{Diesel} = 63\%$
(b) cut-off ratio = 1.5, clearance ratio = 14.28%, $\eta_{Diesel} = 61\%$
(c) cut-off ratio = 2.0, clearance ratio = 7.14%, $\eta_{Diesel} = 63\%$
(d) cut-off ratio = 2.0, clearance ratio = 14.28%, $\eta_{Diesel} = 61\%$

Q.12 Consider the following statements regarding the causes for hydrocarbon emissions from SI engine are:
1. Incomplete combustion.
2. Crevice volumes and flow in crevices.
3. Leakage past the exhaust valve.
4. Valve overlap.
5. Oil on combustion chamber walls.

Which of the above statements are correct?
(a) 1, 2 and 5 only (b) 1, 2, 3 and 5 only
(c) 1, 3 and 5 only (d) 1, 2, 3, 4 and 5

Q.13 Gasohol is a mixture of
(a) 90% ethanol + 10% gasoline
(b) 10% ethanol + 90% gasoline
(c) 20% ethanol + 80% gasoline
(d) 30% ethanol + 70% gasoline

Q.14 The method which can be used to determine friction power of an IC engine is
(a) Willian's line method
(b) Morse test
(c) Motoring test
(d) All of the above

Q.15 A rope brake dynamometer attached to the crank shaft of IC engine measures a brake power of 10 kW when the speed of rotation of the shaft is 400 rad/s. The shaft torque (in Nm) sensed by the dynamometer is
(a) 10 (b) 15
(c) 20 (d) 25

Q.16 Piston rings of engine are made of which of the following material and by which process?
(a) Cast iron and forging
(b) Aluminium and forging
(c) Cast iron and casting
(d) Aluminium and casting

Q.17 Match **List-I (running condition)** with **List-II (AFR)** and select the correct answer using the codes given below:

List-I
A. SI engine - idling
B. SI engine - maximum power
C. SI engine - maximum efficiency
D. CI engine - part load

List-II
1. 35
2. 17
3. 12.5
4. 3

Codes:

	A	B	C	D
(a)	4	3	1	2
(b)	1	2	3	4
(c)	4	3	2	1
(d)	1	2	4	3

Q.18 A 4-stroke diesel engine, when running at 2400 rpm has an injection duration of crank angle as 20°. The corresponding injection duration (in milli-seconds) will be
(a) 2.4 (b) 1.39
(c) 1.12 (d) 0.98

Q.19 Consider the following statements regarding cut-off ratio:

1. The cut-off ratio of a diesel engine cycle should be greater than one, but should be as low as possible.
2. Lower cut-off ratio improves the thermal efficiency.
3. Lower cut-off ratio improves the specific work output.

Which of the statements are correct?

(a) 1 and 2 (b) 2 and 3
(c) 1 and 3 (d) 1, 2 and 3

Q.20 For a 4 cylinder engine, the bore and stroke of the cylinder is 60 mm and 70 mm, respectively. The clearance volume is given as 50 cc. The cubic capacity of the engine is

(a) 842 cc (b) 792 cc
(c) 1232 cc (d) 198 cc

Q.21 The mechanical efficiency of a single-cylinder four stroke engine is 85%. The frictional power is estimated to be 20 kW. The brake power developed by the engine would be

(a) 113.33 kW (b) 133.33 kW
(c) 143.33 kW (d) 153.33 kW

Q.22 Flash point of a fuel oil is

(a) minimum temperature to which oil is heated in order to give off inflammable vapours in sufficient quantity to ignite.
(b) temperature at which it solidifies.
(c) temperature at which it catches fire without external aid.
(d) indicated by 90% distillation temperature.

Q.23 Consider the following statements regarding the use of alcohol as an alternate fuel in IC engine

1. Anti-knock characteristics of alcohol is poor.
2. Heating value of alcohol is about half of that of gasoline.
3. Alcohol does not vaporize as easily as gasoline.
4. Alcohol is corrosive in nature.

Which of the above statements are correct?

(a) 1 and 4 (b) 2, 3 and 4
(c) 2 and 4 (d) 1, 3 and 4

Q.24 Consider the following statements regarding supercharging in SI engines:

1. It leads to decreased detonation tendency.
2. It promotes scavenging.
3. Ignition delay is reduced.
4. Supercharged SI engines have lower thermal efficiency.

Which of the above statement are correct?

(a) 1, 2 and 4 only (b) 1, 2 and 3 only
(c) 2, 3 and 4 only (d) 2 and 3 only

Q.25 Consider the following statements regarding liquid fuels:

1. If alcohol is used then there is a possibility of vapour lock in fuel delivery system.
2. Methanol by itself is not a good CI engine fuel because of its high octane number.
3. Ethanol has less hydrocarbon emission than gasoline but more than methanol.

Which of the above statements are correct?

(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3 only

Q.26 A diesel engine has a brake thermal efficiency of 30%. If the calorific value of fuel is 42000 kJ/kg then brake specific fuel consumption is

(a) 0.1428 kg/kW-h
(b) 0.2857 kg/kW-h
(c) 0.4285 kg/kW-h
(d) 0.2142 kg/kW-h

Q.27 For same compression ratio and same heat rejection, which of the following best describes the relationship between Otto, diesel and dual cycle efficiency?

(a) $\eta_{Otto} > \eta_{Dual} > \eta_{Diesel}$
(b) $\eta_{Diesel} > \eta_{Dual} > \eta_{Otto}$
(c) $\eta_{Dual} > \eta_{Diesel} > \eta_{Otto}$
(d) $\eta_{Dual} > \eta_{Otto} > \eta_{Diesel}$

Q.28 The major loss in a CI engine is
(a) direct heat loss
(b) loss due to incomplete combustion
(c) rubbing friction loss
(d) pumping loss

Q.29 In a four cylinder SI engine, the morse test gave the following results:
BP_1 = 120 kW, BP_2 = 115 kW, BP_3 = 135 kW, BP_4 = 125 kW
If net brake power is 200 kW, the mechanical efficiency of the above engine is
(a) 57% (b) 60%
(c) 66% (d) 69%

Q.30 As compared to air standard cycle, in actual working, the effect of variation in specific heat is to:
(a) increase maximum pressure and temperature.
(b) decrease maximum pressure and temperature.
(c) increase maximum pressure and decrease maximum temperature.
(d) decrease maximum pressure and increase maximum temperature.

■■■■

Answer Keys

1.	(a)	2.	(a)	3.	(b)	4.	(b)	5.	(c)	6.	(c)	7.	(c)
8.	(b)	9.	(a)	10.	(b)	11.	(a)	12.	(d)	13.	(b)	14.	(d)
15.	(d)	16.	(c)	17.	(c)	18.	(b)	19.	(a)	20.	(b)	21.	(a)
22.	(a)	23.	(b)	24.	(c)	25.	(d)	26.	(b)	27.	(a)	28.	(b)
29.	(c)	30.	(d)										

Detailed Solutions

1. (a)

$$\frac{T_2}{T_1} = (r_p)^{n-1} = (8)^{1.5-1} = 2\sqrt{2}$$

T_2 = 885 K

$Q = C_V (T_3 - T_2) = 0.717\ [(1200 + 273) - 885]$
$= 420$ kJ/kg

2. (a)

$P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$

$$\left(\frac{V_1}{V_2}\right)^{\gamma} = \left(\frac{P_2}{P_1}\right) = 35$$

$$\frac{V_1}{V_2} = r = (35)^{1/\gamma} = (35)^{0.7} = 12$$

Cut off ratio, $r_c = \dfrac{r}{r_e} = \dfrac{12}{5} = 2.4$

3. (b)

- Exhaust gas recirculation is an effective method used in IC engines to decrease NO_x emission by decreasing the flame temperatures. When EGR is applied the air-fuel mixture is mixed with a portion of the exhaust gas prior to compression.
- A bomb calorimeter is used to measure higher calorific value of solid and liquid fuels.

4. (b)

Given: $\eta_{bth} = 0.35$, $CV = 40 \times 10^3$ kJ/kg
$\eta_{mech} = 0.75$

$$sfc_i = \frac{\eta_{mech} \times 3600}{\eta_{bth} \times CV} = \frac{0.75 \times 3600}{0.35 \times 40 \times 10^3}$$

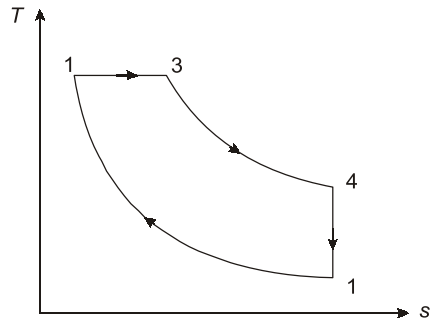
$= 0.193$ kg/kW.hr

5. (c)

The knocking tendency of a diesel engine increases with:

1. decreasing the supercharging of inlet air.
2. increasing the engine speed.
3. decreasing the inlet temperature.
4. decreasing the cylinder block temperature and cooling water temperature.
5. using lower centane rating fuel.
6. decreasing the compression ratio.

6. (c)



$r = \frac{V_1}{V_2} = 14$

$V_1 = 14\ V_2$

$\frac{V_3 - V_2}{V_1 - V_2} = 0.06$

$V_3 - V_2 = 13V_2 \times 0.006$

$r_c = \frac{V_3}{V_2} = 1.78$

7. (c)

Platinum : for hydro carbon (HC)

Palladium : for carbon-mono-oxide (CO)

Rhodium : for oxides of nitrogen (NO_x)

8. (b)

Absence of hot surfaces in the end region of gas is needed to avoid knock.

9. (a)

$\eta_{otto} = 1 - \frac{1}{r^{\gamma-1}}$

As, $\gamma \uparrow \Rightarrow \eta_{otto} \uparrow$

10. (b)

Brake power $= \frac{2\pi NT}{60} = 2 \times \frac{22}{7} \times \frac{300 \times 49}{60}$

$= 1540$ W $= 1.54$ kW

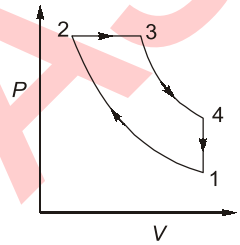
Indicated power $= P_{im} \times \dot{V}_s$

$= 980 \times 10^3 \times \left(790 \times 10^{-6} \times \frac{300}{2 \times 60}\right)$.

$= 1935.5$ W $= 1.935$ kW

$\eta_{mech} = \frac{BP}{IP} = \frac{1.54}{1.935} = 79.58\%$

11. (a)



Diesel Cycle

$r = \frac{V_1}{V_2} = 15$

$r_e = \frac{V_4}{V_3} = 10$

Cut-off ratio $(r) = \frac{r}{r_e} = \frac{15}{10} = 1.5$

Clearance ratio (C)

$\Rightarrow r = 1 + \frac{1}{C} \Rightarrow C = \frac{1}{r-1} = \frac{1}{14}$

$= 0.0714 = 7.14\%$

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

$= 1 - \frac{1}{(15)^{0.4} \times 1.4} \times \left(\frac{(1.5)^{1.4} - 1}{1.5 - 1}\right) = 63\%$

12. (d)

The causes for hydrocarbon emissions from SI engine are :

- Incomplete combustion

- Compression ratio
- Crevice volume and flow in crevices
- Leakage past the exhaust valve
- Oil on combustion chamber walls
- Valve overlap
- Deposits on walls

13. (b)

Gasohol (90% gasoline and 10% ethanol).

14. (d)

The methods used to determine friction power of an IC engine is:

(i) Motoring test
(ii) Morse test
(iii) Willian's line method
(iv) Difference between I.P. and B.P.

15. (d)

Brake power = $T\omega$

$$T = \frac{P}{\omega} = \frac{10000}{400} = 25 \text{ Nm}$$

16. (c)

Piston rings are made of cast iron and are produced by casting. Cast iron easily adheres to the cylinder wall. In addition, cast iron can be easily coated with other materials to enhance its durability.

18. (b)

$$\text{Injection duration, } t = \frac{\theta}{360°} \times \frac{60}{N}$$

$$t = \frac{20}{360} \times \frac{60}{2400}$$

$t = 1.388 \times 10^{-3}$ seconds

t = 1.39 ms

19. (a)

Lower cut-off ratio does improve the thermal efficiency but lowers the specific work output. Hence the value of cut-off ratio must be optimized.

20. (b)

$$V_s = \frac{\pi}{4} D^2 L = \frac{22}{7} \times \frac{1}{4} \times 6 \times 6 \times 7 \text{ cc} = 198 \text{ cc}$$

Cubic capacity = $4 \times V_s = 4 \times 198 = 792$ cc

21. (a)

$$\eta_{mech} = \frac{BP}{IP} = 0.85$$

$$IP - BP = 20$$

$$IP(1 - 0.85) = 20$$

$$IP = \frac{20}{0.15} = 133.33 \text{ kW}$$

$BP = 0.85 \times 133.33 = 113.33$ kW

22. (a)

Flash point of a fuel oil is minimum temperature to which is heated in order to give off inflammable vapours in sufficient quantity to ignite. For gasoline and diesel, flash point is above –43°C and 52°C respectively.

23. (b)

Alcohols have higher antiknock characteristics compared to gasoline. As such with an alcohol fuel, engine compression ratio between 11 : 1 and 13: 1 are usual.

24. (c)

Due to supercharging, there is an increase in both intake temperature and pressure which leads to reduction in ignition delay and increase in flame speed. Both these effects result in a greater tendency to detonate or pre-ignite. For this reason, the supercharged SI engines employ lower compression ratio. Due to this, their thermal efficiency is also lower.

25. (d)

Methanol by itself is not a good CI engine fuel because of its high octane number, but if a small amount of diesel oil is used for ignition, it can be used with good results.

26. (b)

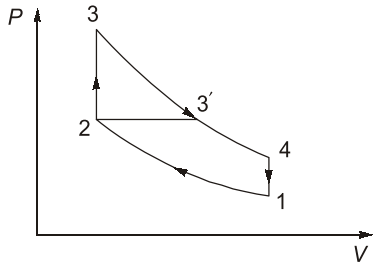
$$\eta_{bth} = \frac{BP}{\dot{m}_f \times CV}$$

$$\Rightarrow \quad \frac{\dot{m}_f}{BP} = \frac{1}{\eta_{bth} \times CV}$$

$$bsfc = \frac{\dot{m}_f}{BP} = \frac{3600}{0.3 \times 42000}$$

$$= \frac{2}{7} = 0.2857 \text{ kJ/kW-h}$$

27. (a)



For same compression ratio and same heat rejection, heat supplied is maximum in Otto cycle, then dual cycle and minimum in diesel cycle.

So, $\eta_{otto} > \eta_{Dual} > \eta_{Diesel}$

28. (b)

The major loss in CI engine is due to incomplete combustion, while in case of SI engine the major loss is due to variation in specific heat and chemical equilibrium.

29. (c)

$IP = IP_1 + IP_2 + IP_3 + IP_4$

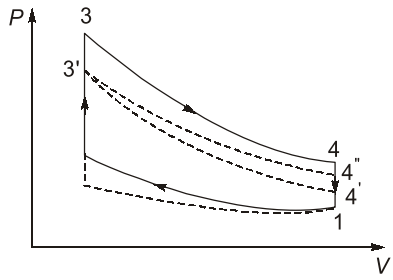
$= (200 - 120) + (200 - 115) + (200 - 135) + (200 - 125) = 305$ kW

$$\eta_{mech} = \frac{BP}{IP} \times 100 = \frac{200}{305} \times 100 = 65.57\%$$

30. (d)

All gasses except monatomic gases show an increase in specific heat with the increase in temperature, but difference between C_P and C_V remains unchanged and specific heat ratio decreases, in turn, cycle efficiency decreases. Since efficiency decreases so maximum temperature and maximum pressure also decreases.

In actual working cycle, variation in specific heat due to change in temperature results in decrease maximum pressure and maximum temperature.



Process: 1- 2 - 3 - 4 = Air standard cycle

Process: 1- 2′ - 3′ - 4″= Actual working cycle

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