Name: **Enrolment No:** **Roll No.**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, July 2020

Course: I C Engines **Semester: IV th Semester**
Program: B.Tech. ADE **Time 03 hrs.**
Course Code: MEAD2002 **Max. Marks: 100**
Instructions:
1. Assume the suitable data and mention in solution at start.
2. Draw the necessary diagrams.

Note:

1. Read the instruction carefully before attempting.

2. This question paper has **two section**, Section A & Section B.

3. There are total of 50 Multiple choice questions in this question paper

4. **Section A** consist of multiple choice based questions and has the total weightage of **50%**.

5. **Section A** will be conducted online on BB Collaborate platform

6. Section B is also of **50 Marks** to be completed in **4 hrs.**

6. The maximum time allocated to **Section A** is **Two Hrs.**

7. Section A/ Section B cover the entire syllabus.

13. The COs mapping is same as earlier

SECTION –A (MCQ Questions)- Attempt all questions.

Q1 which one of the following is NOT a necessary assumption for the air standard Otto cycle?

(a) All processes are both internally as well as externally reversible.

(b) Intake and exhaust processes are constant volume heat rejection processes.

(c) The combustion process is a constant volume heat addition process.

(d) The working fluid is an ideal gas with constant specific heats.

Q2 An engine working on air standard Otto cycle has a cylinder diameter of 10 cm and stroke length of 15 cm. The ratio of specific heats for air is 1.4. If the clearance volume is 196.3 cc and the heat supplied per kg of air per cycle is 1800kJ/kg, then work output per cycle per kg of air is

(a) 879.1 kJ (b) 890.2 kJ (c) 895.3 kJ (d) 973.5 kJ

Q 3 For an engine operating on air standard Otto cycle, the clearance volume is 10% of the swept volume. The specific heat ratio of air is 1.4. The air standard cycle efficiency is

(a) 38.3% (b) 39.8% (c) 60.2% (d) 61.7%

Q 4 In a spark ignition engine working on the ideal Otto cycle, the compression ratio is 5.5. The work output per cycle (i.e., area of the P-V diagram) is equal to 23.625 x 105 x Vc J, where Vc is the clearance volume in m3. The indicated mean effective pressure is

(a) 4.295 bar (b) 5.250 bar (c) 86.870 bar (d) 106.300 bar

Q 5 A diesel engine is usually more efficient than a spark ignition engine because

(a) diesel being a heavier hydrocarbon, releases more heat per kg than gasoline

(b) The air standard efficiency of diesel cycle is higher than the Otto cycle, at a fixed compression ratio

(c) The compression ratio of a diesel engine is higher than that of an SI engine

(d) Self ignition temperature of diesel is higher than that of gasoline

Q 6 Consider air standard Otto and Diesel cycles, both having the same state of air at the start of compression. If the maximum pressure in both the cycles is the same, then compression ratio 'r' and the efficiency 'η' are related by

(a) r Diesel > r Otto (b) r Diesel < r Otto (c) η Otto > η Diesel (d) η Otto < η Diesel

Q 7 Consider the following statements:

1. For a Diesel cycle, the thermal efficiency decreases as the cut off ratio increases.

2. In a petrol engine the high voltage for spark is in the order of 1000 V

3. The material for centre electrode in spark plug is carbon. Which of the statements given above is/are correct?

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

Q 8 Otto cycle efficiency is higher than Diesel cycle efficiency for the same compression ratio and heat input because, in Otto cycle

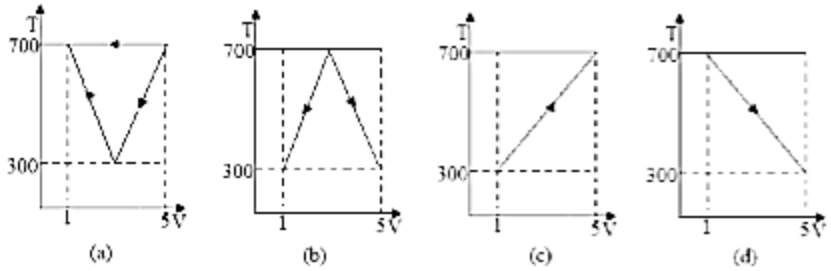
(a) Combustion is at constant volume

(b) Expansion and compression are isentropic

(c) Maximum temperature is higher

(d) Heat rejection is lower

Q 9 Which one of the following hypothetical heat engine cycle represents maximum efficiency?



Q 10 For the same maximum pressure and temperature

(a) Otto cycle is more efficient than diesel cycle

(b) Diesel cycle is more efficient than Otto cycle

(c) Dual cycle is more efficient than Otto and diesel cycles

(d) Dual cycle is less efficient than Otto diesel cycles

Q 11 Knocking tendency in a S.l. engine reduces with increasing

(a) Compression ratio (b) wall temperature (c) Supercharging (d) engine speed

Q12 The stoichiometric air/fuel ratio for petrol is 15: 1. What is the air/fuel ratio required for maximum power?

(a) 16 : 1 - 18 : 1 (b) 15 : 1 (c) 12 : 1 - 18 : 1 (d) 9: 1 - 11 : 1

Q 13 Velocity of flame propagation in the SI engine is maximum for a fuel-air mixture which is (a) 10% richer than stoichiometric (b) Equal to stoichiometric

(c) More than 10% richer than stoichiometric (d) 10% leaner than stoichiometric

Q 14 Which of the following factors increase detonation in the SI engine?

1. Increased spark advance.

2. Increased speed. 3. Increased air-fuel ratio beyond stoichiometric strength

4. Increased compression ratio. Select the correct answer using the codes given below:

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

Q 15 Consider the following statements:

1. In the SI engines detonation occurs near the end of combustion whereas in CI engines knocking occurs near the beginning of combustion.

2. In SI engines no problems are encountered on account of pre-ignition.

3. Low inlet pressure and temperature reduce knocking tendency in SI engines but increase the knocking tendency in CI engines. Which of the statements given above are correct?

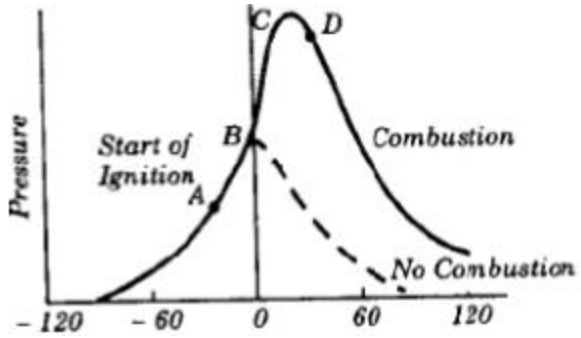
(a) 1, 2 and 3 (b) Only 1 and 2 (c) Only 2 and 3 (d) Only 1 and 3

Q16 For minimizing knocking tendency is SI engine, where should the space plug be located? (a) Near inlet valve (b) Away from both the valves (c) Near exhaust valve (d) Midway between inlet and exhaust valves

Q 17 The knocking tendency in compression ignition engines increases with:

(a) Increase of coolant water temperature
(b) Increase of temperature of inlet air
(c) Decrease of compression ratio
(d) Increase of compression ratio

Q18 Hypothetical pressure diagram for a compression ignition engine is shown in the given figure. The diesel knock is generated during the period



(a) AB (b) BC (c) CD (d) after D

Q 19 In the operation of four-stroke diesel engines, the term 'squish' refers to the:

(a) Injection of fuel in the pre-combustion chamber

(b) Discharge of gases from the pre-combustion chamber

(c) Entry of air into the combustion chamber

(d) Stripping of fuel from the core

Q 20 The correct sequence of the decreasing order of brake thermal efficiency of the three given basic type of IC engines is

(a) 4 stroke CI engine, 4 stroke SI engine, 2 stroke SI engine

(b) 4 stroke SI engine, 4 stroke CI engine, 2 stroke SI engine

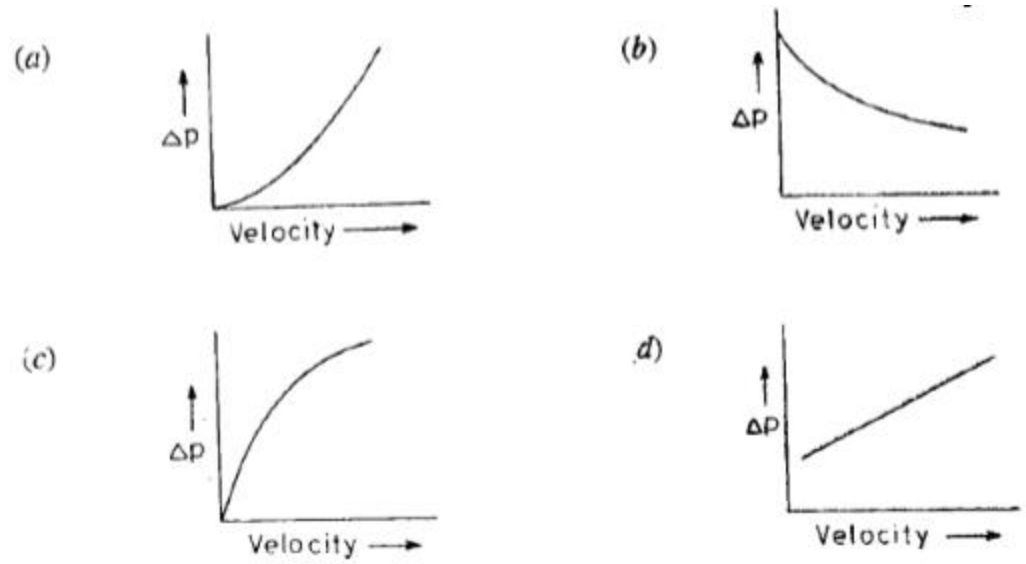
(c) 4 stroke CI engine, 2 stroke SI engine, 4 stroke SI engine

(d) 2 stroke SI engine, 4 stroke SI engine, 4 stroke CI engine.

Q 21 At the time of starting, idling and low speed operation, the carburetor supplies a mixture which can be termed as

(a) Lean (b) slightly leaner than stoichiometric (c) stoichiometric (d) rich

Q 22 Which one of the following curves is a proper representation of pressure differential (y-axis) vs velocity of air (x-axis) at the throat of a carburetor?



Q 23 Consider the following statements:

The injector nozzle of a CI engine is required to inject fuel at a sufficiently high pressure in order to

1. be able to inject fuel in a chamber of high pressure at the end of the compression stroke.

2. Inject fuel at high velocity to facilitate atomization.

3. Ensure that penetration is not high.

Which of the above statements are true;

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

Q24 What is the purpose of employing supercharging for an engine?

(a) To provide forced cooling air

(b) To raise exhaust pressure

(c) To inject excess fuel for coping with higher load

(d) To supply an intake of air at a density greater than the density of the surrounding atmosphere

Q 25 During a Morse test on a 4 cylinder engine, the following measurements of brake power were taken at constant speed.

All cylinders firing 3037 kW

Number 1 cylinder not firing 2102 kW

Number 2 cylinder not firing 2102 kW

Number 3 cylinder not firing 2100 kW

Number 4 cylinder not firing 2098 kW

The mechanical efficiency of the engine is

(a) 91.53% (b) 85.07% (c) 81.07% (d) 61.22%

Q 26 An automobile engine operates at a fuel air ratio of 0.05, volumetric efficiency of 90% and indicated thermal efficiency of 30%. Given that the calorific value of the fuel is 45 MJ/kg and the density of air at intake is 1 kg/m^3, the indicated mean effective pressure for the engine is

(a) 6.075 bar (b) 6.75 bar (c) 67.5 bar (d) 243 bar

Q 27 In a Morse test for a 2-cylinder, 2-stroke, spark ignition engine, the brake power was 9 kW whereas the brake powers of individual cylinders with spark cut of were 4.25 kW and 3.75 kW respectively. The mechanical efficiency of the engine is

(a) 80% (b) 90% (c) 45.5% (d) 52.5%

Q 28 Besides mean effective pressure, the data needed for determining the indicated power of an engine would include

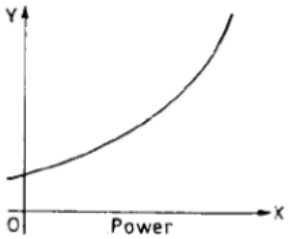
(a) Piston diameter, length of stroke and calorific value of fuel

(b) Piston diameter, specific fuel consumption and calorific value of fuel

(c) Piston diameter, length of stroke and speed of rotation

(d) Specific fuel consumption, speed of rotation and torque

Q 29 The curve show in the given figure is characteristic of diesel engines. What does the Y-axis represent?



(a) Efficiency (b) Specific fuel consumption

(c) Air-fuel ratio (d) Total fuel consumption

Q 30 Which one of the following quantities is assumed constant for an internal combustion engine while estimating its friction power by extrapolation through Willam's line?

(a) Brake thermal efficiency (b) Indicated thermal efficiency.

(c) Mechanical efficiency (d) Volumetric efficiency.

Q 31 An engine produces 10 kW brake power while working with a brake thermal efficiency of 30%. If the calorific value of the fuel used is 40, 000 kJ/Kg, then what is the fuel consumption?

(a) 1.5 kg/hour (b) 0.3 kg/hour

(c) 3.0 kg/hour (d) 1.0 kg/hour

Q 32 A 40 kW engine has a mechanical efficiency of 80%. If the frictional power is assumed to be constant with load, what is the approximate value of the mechanical efficiency at 50% of the rated load?

(a) 45% (b) 55% (c) 75% (d) 65%

Q 33 Consider the following statements in respect of automobile engine with thermo-syphon cooling:

1. Heat transfer from gases to cylinder walls takes place by convection and radiation.

2. Most of the heat transfer from radiator to atmosphere takes place by radiation.

3. Most amount of heat transfer from radiator to atmosphere takes place by convection.

4. Heat transfer from cylinder walls takes place by conduction and convection.

Which of the above statements are correct?

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

Q 34 The silencer of an internal combustion engine

(a) Reduces noise (b) decrease brake specific fuel consumption (BSFC)

(c) Increase BSFC (d) has no effect on its efficiency

Q 35 Which one of the following set of materials is most commonly used in catalytic converters for CI engines?

(a) Platinum, palladium and rhodium (b) Palladium, rhodium and ruthenium

(c) Rhodium, ruthenium and platinum (d) Ruthenium, platinum and palladium

Q 36 The three way catalytic converter cannot control which one of the following?

(a) HC emission (b) CO emission (c) NOx emission (d) PM emission

Q 37 Which of the following symptoms shows that the combustion is necessarily complete?

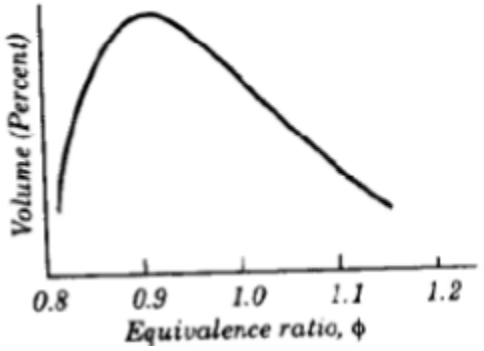
(a) Presence of free carbon in exhaust

(b) Presence of CO in exhaust

(c) Presence of nitrogen in exhaust

(d) Presence of oxygen in exhaust

Q 38 The graph shown in the given figure represents the emission of a pollutant from an SI engine for different fuel/air ratios. The pollutant in question is



(a) CO (b) CO2 (c) hydrocarbons (d) NOx

Q 39 Which one of the following automobile exhaust gas pollutants is a major cause of photochemical smog?

(a) CO (b) HC (c) NOx (d) SOx

Q 40 Consider the following statements for NOx emissions from I.C. engines:

1. Formation of NOx depends upon combustion temperature

2. Formation of NOx depends upon type of coolant used

3. Exhaust gas recirculation is an effective means for control of NOx

4. Activated Platinum is used for reduction of NOx

Which of the statements given above are correct?

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

Q 41 Compression ratio of LC. engines is

(a) the ratio of volumes of air in cylinder before compression stroke and after compression stroke

(b) volume displaced by piston per stroke and clearance volume in cylinder

(c) ratio of pressure after compression and before compression

(d) swept volume/cylinder volume

Q 42 If the compression ratio of an engine working on Otto cycle is increased from 5 to 7, the percentage increase in efficiency will be
(a) 2%
(b) 4%
(c) 8%
(d) 14%

Q 43 The precess of breaking up or a lipuid into fine droplets by spraying is called
(a) vaporization (b) carburetion

(c) atomization (d) vaporization

Q 44 Which of the following is one of the major exhaust emissions from CI engines compared to SI engines?

(a) Oxides of nitrogen

(b) Particulates

(c) Carbon monoxide and Carbon dioxide

(d) Unburnt hydrocarbon

Q 45 Pour point of fuel oil is the

(a) temperature at which it solidifies or congeals

(b) it catches fire without external aid

(c) indicated by 90% distillation temperature i.e., when 90%. of sample oil has distilled off

(d) temperature at which it flows easily

Q 46 The air-fuel ratio of the petrol engine is controlled by

(a) Fuel pump
(b) Carburetor
(c) Governor
(d) Throttle body injection

Q 47 Which of the following statement is wrong?

(a) In compression ignition engines, detonation occurs near the beginning of combustion.
(b) Since the fuel, in compression ignition engines, is injected at the end of compression stroke, therefore, there will be no pre-ignition.
(c) To eliminate knock in compression ignition engines, we want to achieve auto-ignition not early and desire a long delay period.
(d) In compression ignition engines, because of heterogeneous mixture, the rate of pressure rise is comparatively lower.

Q 48 In a diesel engine, the duration between the time of injection and ignition, is known as
(a) Delay period
(b) After burning
(c) Controlled combustion period
(d) Period of combustion

Q 49 The injector nozzle of a compression ignition engine is required to inject fuel at a sufficiently high pressure in order to;
(a) Inject fuel in a chamber of high pressure at the end of compression stroke
(b) Inject fuel at a high velocity to facilitate atomization
(c) Ensure the combustion without delay
(d) All of above

Q 50 A fuel of cetane number 40 has the same ignition quality as a mixture of

(a) 40% alpha methyl naphthalene and 60% cetane
(b) 40% cetane and 60% alpha methyl naphthalene
(c) 40% petrol and 60% diesel
(d) 60% petrol and 40% diesel

Section – B (Attempt all the questions)-50 Marks

Use of steam table is allowed. Use the standard properties of air as Υ=1.4, Cp= 1.005 kJ/kgK, Cv = 0.714 kJ/kgK, *where* Υ = Cp/ Cv

Paper consisting of ***five problems****. Assume the suitable data if not provided Time duration to solve the problems is limited to 4 hrs for each student which includes the submission of the solution on blackboard. There is internal choice in Q.No. 3. Any issue may be escalated to concern faculty member through mail/Call etc.*

S. No.	Statement of question	Marks	CO
	SECTION A		
Q 1	An oil engine works on the ideal diesel cycle. The overall compression ratio is ***(18+0.01 x A):1*** and the heat is added at constant pressure in 10% of stroke volume (V_3-V_2= 10% V_s). Intake conditions are 1 bar and 20^0 C . The engine uses 100m^3 of air per hour. Use standard properties of air Υ=1.4, Cp= 1.005 kJ/kg, Cv = 0.714 kJ/kg etc. Determine; 1. Max temperature/ pressure of cycle, 2. thermal efficiency of engine & indicated power of the engine and 3. mean effective pressure. ***Where A is last two digit of your roll no i.e . Example last two digits are 22 then constant A will be 22.***	**10**	**CO1**
Q 2	Explain the requirements of fuel injection system used for CI Engines. Correlate the fuel injection characteristics curve with the combustion model and explain with help of suitable p-θ and heat release rate diagrams.	**10**	**CO2**
Q 3	Critically analyse the effect of 5 operating and design parameters on emission ((HC, CO & NO) of SI and CI engines and make your inferences. **OR** Discuss the formation of NOx in diesel engines with Zaldowich reaction and suggest the EGR control technology to reduce the emission with suitable diagrams. Also indicate the influence of EGR	**8**	**CO3**
Q 4	Explain the genesis/ formation of Hydrocarbon (%) with the help of flow chart. Also explain the principle of operation of 3-way catalytic converter to reduce the emission of SI engines.	**7**	**CO3**
Q 5	(A) Following readings were taken during a test on single cylinder 4 –stroke oil engine ;	**10**	**CO4**

Cylinder bore	***(250+ A)mm***
Stroke length	***(400+B) mm***
Indicated mean effective pressure	***(6.8+ 0.01 x C)bar***
Engine speed	***(300+ D) rpm***
Fuel oil used per hour	***(3.4+ 0.01 x E) kg***
Calorific value of fuel	***(42000+ 100x F) kJ/kg***
Brake torque	***(480+ G) Nm***
Mass of jacket cooling water per minute	***(5.1+0.01x H) kg***

Rise in temperature of jacket cooling water	***40^0C***
Mass of air supplied per minute	***(1.35+0.01 x I) kg***
Temperature of exhaust gases	***350^0C***
Room temperature	***20^0 C***
Mean specific heat of dry exhaust gases	***1.1 kJ/kg***
Hydrogen in fuel on mass basis	***12.5 %***
Specific heat of steam in exhaust gases	***2.1 kJ/kgK***
Pressure of steam in exhaust gases	***1.01325 bar***
Specific heat of water	***4.18 kJ/kgK***

Calculate the mechanical and indicated thermal efficiencies and brake specific fuel consumption. Also draw up the heat balance sheet in kJ/min and as percentage of heat supplied to engine with help of pie chart/ Sanky's diagram. Analyse the heat balance and make your conclusions.

Where A, B, C ,D, E, G, H, I are constant to be considered as last two digit of your roll no i.e . Example last two digits are 22 then constant will be 22.

(B) A four stroke petrol engine having **Six** cylinder of 90 mm bore and stroke 100 mm runs at 2000 rpm and develops 50 kW. When one cylinder at a time is 'cut off' during the **Morse test** , the mean BP (brake power) developed is 40 kW. The thermal efficiency on IP (indicated power) basis when all the cylinders are operative is 30% with petrol having calorific value of 45000 kJ/kg. The air fuel ratio is **14. 5 : 1, calculate**

(a) Mechanical efficiency
(b) Brake specific fuel consumption
(c) The volumetric efficiency, if air is measured at 1 bar and 0 ^{0}C.