

SYED AMMAL ENGINEERING COLLEGE

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VIII Semester ME 6016 – ADVANCED IC ENGINES

Part-A

UNIT – 1

1. What are the stages of combustion in a SI engines?

The stages of combustion in a SI engines are:

FIRST STAGE: Ignition lag (or) preparation phase

SECOND STAGE: propagation of flame

THIRD STAGE: After burning

2. What are the various factors that affect the flame speed?

a) Turbulence b) F/A ratio c) T, P d) Compression ratio e) Engine speed, size & output

3. Define normal combustion?

In normal combustion, the flame initiated by the spark travels across the combustion chamber in a fairly uniform manner.

4. Define abnormal combustion and its consequences?

Under certain operating conditions the combustion deviates from its normal Course leading to loss of performance and possible damage to the engine are termed as abnormal combustion (or) knocking combustion. Consequences are (1). Loss of power (2). Recurring preignition (3). Mechanical damage to the engine

5. What is equivalence ratio?

The ratio of the actual fuel-air ratio to the stoichiometric fuel –air ratio.

6. Short note on SI engine equivalence ratio requirements?

In a homogeneous mixture with equivalence ratio close to 1.0 the flame speed is normally of the order of 40cm/s .However in a SI engine the maximum flame speed is obtained when ϕ is between 1.1 and 1.2 (i.e.) when the mixture is slightly richer than stoichiometric.

7. Write the desirable qualities for SI engine fuel?

In order to avoid or inhibit detonation, a high auto ignition temperature and a long ignition lag are the desirable qualities for SI engine fuel.

8. Explain the type of vibration produced when auto ignition occurs.

Two different vibrations are produced.

1. In one case, a large amount of mixture may auto ignite giving use to a very rapid increase in pressure throughout the chamber and there will be a direct blow on free vibration of the engine parts

2. In another case, larger pressure differences may exist in the combustion chamber and the resulting gas vibration can force the walls of the chamber to vibrate at the same frequency as the gas.

9. What is the method to detect the phenomenon of knocking?

The scientific method to detect the phenomenon of knocking is to use a pressure transducer. This transducer is connected, usually to a cathode ray oscilloscope. Thus pressure-time traces can be obtained from the pressure transducer.

10. List out some of the knock limited parameters?

The knock limited parameters are:

1. Knock limited compression ratio
2. Knock limited intake pressure
3. Knock limited Indicated mean effective pressure. (Kimep)

11. Define performance number?

Performance number is defined as the ratio of Knock limited Indicated mean effective pressure with the sample fuel to knock limited Indicated mean effective pressure with ISO-OCTANE when the inlet pressure is kept constant.

12. List the factors that are involved in either producing (or) preventing knock.

The factors that are involved in either producing (or) preventing knock are temperature, pressure, density of the unburned charge and the time factor.

13. List the parameters which are affecting knock in SI engine?

The parameters which are directly (or) indirectly connected with knocking are inlet temperature of mixture, compression ratio, mass of inducted charge, power output of the engine.

14. List the parameters in time factors that reduce the knocking?

Parameters are turbulence, engine speed, flame travel distance, combustion chamber shape and location of spark plug.

15. List the composition factors in the knocking?

Air-fuel ratio and octane value of the fuel are the composition factors.

16. What are the objectives to be kept in mind during design of combustion chamber?

General objectives are

- (a) Smooth engine operation
- (b) Moderate rate of pressure rise
- (c) Reducing the possibility of knocking
- (d) High power output and thermal efficiency

17. What are the factors to be considered to obtain high thermal efficiency?

Following are the factors:

1. A high volumetric efficiency.
2. Anti knock characteristic must be improved.
3. Compact combustion chamber reduces heat loss during combustion increases the thermal efficiency.

18. Write the different types of combustion chambering SI engine?

T-Head type, L- Head type, I- Head type, F- Head type.

19. What are the components required in the fuel injection system?

Components are –pumping element, metering element, mixing element, distributing element, Timing control, and ambient control.

20. What are the advantages of fuel –injection in an SI engine?

Advantages are:

1. Increased volumetric efficiency.
2. Better thermal efficiency
3. Lower exhaust emissions
4. High quality fuel distribution.

21. List the drawbacks of the carburetion?

1. Non uniform distribution of mixture in multi cylinder engines.
2. Loss of volumetric efficiency due to retraction for mixture flow and possibility of back firing.

22. What are the functional requirements of an injection system?

1. Accurate mixing of the fuel injected per cycle.
2. Timing the injection of the fuel.
3. Proper atomization of fuel into fine droplets
4. Proper spray pattern.
5. No lag during beginning and end of injection.

23. List some of the important requirements of an automobile carburetors?

1. Ease of starting the engine, particularly under low ambient conditions.
2. Good and quick acceleration of the engine.
3. Good fuel economy.
4. Ensuring full torque at low speeds.

24. What are the general types of carburetors?

Types are UPDRAUGHT, DOWN DRAUGHT, and CROSS DRAUGHT.

25. What are the essential parts, compensating device and additional system (modern) carburetors?

Parts – fuel strainer, float chamber, main metering and idling system, the choke & the throttle. Compensating devise- Air –bleed jet, compensating jet, Emulsion tube, auxiliary valve and port, back suction control mechanism. Additional system –Ant dieseling, richer coasting, acceleration pump and economic (or) power enrichment system.

26. Define carburetion?

The process of formation of a combustible fuel –air mixture by mixing the proper amount of fuel with air before admission to engine cylinder is called carburetion.

27. What are the factors effecting carburetion?

1. The engine speed

2. The vaporization characteristics of fuel
3. The temperature of the incoming air
4. The design of the carburetor

28. What are the different types air –fuel mixtures?

1. Chemically correct mixture
2. Rich mixture
3. lean mixture.

29. What are the different range of throttle operation

1. Idling
2. cruising
3. High power .

UNIT – II

1. What are the stages of combustion in C.I engine?

The stages of combustion in C.I engine are four stages:

Stage I: ignition delay period (preparatory phase) Stage 2: Period of rapid combustion.

Stage 3: Period of controlled combustion. Stage 4: Period of after burning.

2. What is ignition delay period?

The fuel does not ignite immediately upon injection into the combustion chamber. There is a definite period of inactivity between the time when the first droplet of fuel hits the hot air in the combustion chamber and the time it starts through the actual burning phase. This period is known as ignition delay period.

3. What are two delays occur in ignition delay period?

The two delays occur in ignition delay period are the physically delay and chemically delay. Physical delay is the time between the beginning of injection and the attainment of chemical reaction conditions. Chemical delay is the reaction starts slowly and then accelerates until the inflammation or ignition takes place.

4. List the factors affecting the delay period?

The factors affecting the delay period are:

1. Compression ratio.
2. Atomization of the fuel
3. Quality of the fuel.
4. Intake temperature and pressure.

5. Explain the effect of quality of fuel factor on the delay period?

Self-ignition temperature is the most important property of the fuel which affects the delay period. A lower self-ignition temperature and fuel with higher cetane number give lower delay period and smooth engine operation. Other properties of the fuel which affects the delay period are latent heat, viscosity and surface tension.

6. Give a comparative statement various characteristics that reduces knocking in S.I and C.I engine (any four)?

S.NO	CHARACTERISTICS	S.I ENGINE	C.I ENGINE
1	Ignition	High	low

	temperature of fuel		
2	Ignition delay	long	short
3	Compression ratio	Low	high
4	Inlet temperature and pressure	Low	HIGH

7. Write the classification of combustion chamber in C.I engine?

Combustion chamber in C.I engine is classified into two categories:

1. Direct-injection type
2. Indirect-injection type.

8. What is called direct injection type of combustion chamber?

Direct injection type of combustion chamber is also called an open combustion. In this type the entire volume of the combustion chamber is located in the main cylinder and the fuel is injected into this volume.

9. What are the types of open combustion chamber?

In open combustion chamber there are many designs some are

- a. Shallow depth chamber
- b. Hemispherical chamber
- c. Cylindrical chamber
- d. Toroidal chamber

10. What are the advantages and disadvantages of open combustion chamber type?

Advantages:

1. Minimum heat loss during compression because of lower surface area to volume ratio
2. No cold starting problems
3. Fine atomization because of multihole nozzle

Disadvantages:

1. High fuel injection pressure required and hence complex design of fuel injection pump
2. Necessity of accurate metering of fuel by the injection system, particularly for small engines.

11. What is indirect injection type of combustion?

Indirect injection type of combustion chamber in which the combustion space is divided into two or more distinct compartments connected by restricted passages.

This creates considerable pressure difference between them during the combustion process.

12. Write the classification of indirect injection chamber (divided combustion chamber)

Classification of divided combustion chamber is

- a. Swirl chamber – in which compression swirl is generated.
- b. Precombustion chamber – in which combustion swirl is induced.
- c. Air cell chamber – in which both compression and combustion swirl are induced.

13. What are the applications of swirl chamber?

Swirl chamber type finds application

- a. Where fuel quality is difficult to control
- b. Where reliability under adverse condition is more important than fuel economy
- c. Use of single hole of larger diameter for the fuel spray nozzle is often important consideration for the choice of fluid chamber engine.

14.) List the advantages and drawbacks of indirect injection chamber:

Advantages:

1. Injection pressure required is low
2. Direction of spraying is not very important

Disadvantages:

15. Why specific fuel consumption is high in indirect injection type combustion chamber:

Specific fuel consumption is high because there is a loss of pressure due to air motion through the duct and heat loss due to large heat transfer area.

16. What is turbo charging?

Energy available in the engines exhaust gas is used to drive the the turbocharger compressor, which raises the inlet fluid density prior to entry to each engine cylinder. This is called turbo charging.

17. What are the major parts of a turbocharger?

The major parts of a turbocharger are turbine wheel, turbine housing, turbo shaft, compressor wheel, compressor housing and bearing housing.

18. Explain the term turbo lag.

In case of turbo charging there is a phenomenon called turbo lag, which refers to the short delay period before the boost or manifold pressure, increase. This is due to the time the turbocharger assembly takes the exhaust gases to accelerate the turbine and compressor wheel to speed up.

19. Explain the function of waste gate.

In the turbocharger assembly there is a control unit called waste gate. It is a diaphragm operated valve that can bypass part of the gases around the turbine wheel when manifold pressure is quite high this unit limits the maximum boost pressure to prevent detonation in S.I engines and engine damage.

20. Why there is a large pressure differences across the injector nozzle are required:

The fuel is introduced in to the cylinder of a diesel engine through a nozzle with a large pressure differences across the nozzle jet will enter the chamber at high velocity to

1. Atomize in to small sized droplets to enables rapid evaporation and
2. Traverse the combustion chamber in the time available and fully utilize the air charge.

21. What is called break up length?

The liquid column bearing the nozzle disintegrates with in the cylinder over a finite Length called the break up length in to drops of different sizes.

22. What are the different designs of nozzle used?

The different design of nozzle used is single orifice, multiorifice, throttle or pintle depending on the needs of the combustion system employed

23. What are the two types of photographic technique used?

To distinguish the liquid – containing core of the jet and the extracts of the fuel vapor region of the spray, which surrounds the liquid core, two types of photographic technique used are backlighting and shadow graph.

24. Explain photographic techniques method:

Back lighting identifies region where sufficient liquid fuel (as ligaments or drops) is present to attenuate the light. The shadowgraph technique responds to density gradients in the test section so it identifies regions where fuel vapor exists.

25. List the droplet size depends on various factors:

The droplet sizes depends on various factors are

1. Mean droplet size decreases with increases in a. Injection pressure b. air density
2. Mean droplet size increases with increases in fuel viscosity.
3. Size of droplets increases with increases in the size of the orifice.

26. Define flame development angle:

The crank angle interval between the spark discharge and the time when a small but significant fraction of the cylinder mass has burned or fuel chemical energy has been released

27. Define rapid burning angle:

The crank angle interval required to burn the bulk of the charge is defined as the interval between the end of the flame development stage and the end of the flame propagation process.

UNIT - III

1. What are the major exhaust emissions? □

The major exhaust emissions are

- a. Unburnt hydrocarbons (HC)
- b. Oxides of carbon (CO and CO₂)
- c. Oxides of nitrogen (NO and NO₂)
- d. Oxides of sulphur (SO₂ and SO₃)
- e. Particulates
- f. Soot and smoke

2. What are the causes for hydrocarbon emission from S.I engine □

The causes for hydro carbon emission from S.I engine are

1. Incomplete combustion.
2. Crevice volume and flow in crevices.
3. Leakage past the exhaust valve.
4. Valve over lap.
5. Deposits on walls.
6. Oil on combustion chamber walls.

3. What are the reasons for incomplete combustion in SI engine?

Incomplete combustion is due to

- a. Improper mixing due to incomplete mixing of the air and fuel. Some fuel particles do not find the oxygen to react with this cause the emissions.
- b. Flame quenching: As the flame goes very close to the walls it gets quenched at the walls leaving a small volume of unreacted air fuel mixture.

4. What are the reasons for flame quenching? □

The reason for flame quenching is the expansion of gases. (i) As the piston moves down from TDC to BDC during power stroke, expansion of the gases lowers both pressure and temperature with in the cylinder. This makes combustion slow and finally quenches the flame and causes the emissions. (ii) High exhaust gas

contamination causes poor combustion and which in turn causes quenching during expansion. iii) As the flame goes very close to the walls it gets quenched at the walls leaving a small volume of unreacted air-fuel mixture.

5. How the oil consumption increases in IC engines and what are the effects □

Often as engines age, due to wear, clearance between the pistons and cylinder wall increases. This increases oil consumption contributes to increases in the emissions in three ways.

a. There is an added crevices volume.

b. There is added absorption – desorption of fuel in the thicker oil film on cylinder walls

c. There is oil burned in the combustion process

6. Write a short note on carbon monoxide emissions □

Carbon monoxide is a colourless and odourless but a poisonous gas. It is generated in an engine when it is operated with a fuel rich equivalence ratio. Poor mixing, local rich regions, and incomplete combustion will also be the source for CO emissions.

7. What is photochemical smog? □

NO_x is the primary causes of photochemical smog, Smog is formed by the photochemical reaction of automobiles exhaust and atmospheric air in the presence of sunlight.

NO₂ + energy from sunlight □ NO + O + smog

8. What are soot particles? □

Soot particles are clusters of solid carbon spheres. These spheres have diameter from 9nm to 90nm (1nm = 10⁻⁹). But most of them are within the range of 15 – 30nm. The spheres are solid carbon with HC and traces of other components absorbed on the surface. Single soot particles may contain up to 5000 carbon spheres.

9. Which is the most effective after treatment for reducing engine emissions □

The catalytic converter is the most effective after treatment for reducing engine emissions found on most automobiles. CO can be oxidized to CO₂ and H₂O in exhaust system and thermal converters if the temperature is held at 600- 700°C. If certain catalysts are present, the temperature needed to sustain these oxidation processes is reduced to 250 - 300°C, making for a much more attractive system.

10. What is a catalyst? □

A catalyst is a substance that accelerates chemical reaction by lowering the energy needed for it to proceed. The catalyst is not consumed in the reaction and so functions indefinitely unless degraded by heat age contaminants or other factors.

11. List the materials used as catalyst □

The catalyst materials most commonly used are a. platinum b. palladium c. rhodium.

12. Why catalytic converter called as three way converters □

Catalytic converters are called as three way converters because they are used to reduce the concentration of CO, HC and NO_x in the exhaust.

13. What are the types of ceramic structure used in catalytic convertor? □

Inside the container is a process ceramic structure through which the exhaust gas flows.

- a. The ceramic is a single honey comb structure with many flow passages.
- b. Some converters use loose granular ceramic with the gas passing between the packed spheres.

14. List out the drawbacks of catalytic converters □

a. Sulphur offers unique problems for catalytic converters some catalyst promote the conversion of SO₂ to SO₃ which eventually converted to sulphuric acid. This degrades the catalytic convertor and contributes to acid rain.

b. Catalytic converters are not very efficient when they are cold. When an engine is started after not being operated for several hours it takes several minute for the converter to reach an efficient operating temperature called as cold start up problem.

15. What are the methods of catalytic converters preheating?

The methods of catalytic converters preheating included the following

- a. By locating the converters close to the engine
- b. By having superinsulation
- c. By employing electric preheating
- d. By using flame heating
- e. Incorporating thermal batteries.

16. List the invisible and visible emission

Invisible emission: Water vapour, carbon dioxide, oxides of nitrogen, unburnt hydrocarbons, carbon monoxide, aldehydes.

Visible emission: Smoke, particulate.

17. What are the methods of measuring the following emission?

- a. Oxides of nitrogen = CHEMILUMINESCENCE ANALYZER
- b. Carbon monoxide = NON DISPERSIVE INFRARED ANALYZER
- c. Unburned hydrocarbons = FLAME IONIZATION DETECTOR (FID)

UNIT-IV

1. Write the advantage and disadvantage of alcohol as a fuel?

The advantages of alcohols a fuel are:

1. it is a high octane fuel with antiknock index number (octane number) of over 100.
2. Alcohols have low sulphur content in the fuel.
3. It produces less overall emissions when compared with gasoline

Disadvantages:

1. Alcohols have poor ignition characteristics in general.
2. There is a possibility of vapor lock in fuel delivery system.

3. It has poor cold weather starting characteristics due to low vapor pressure and evaporation.

2. What is the problem with gasoline-alcohol mixture as a fuel?

Problems with gasoline-alcohol mixture as a fuel are the tendency for alcohol to combine with any water present. When this happens the alcohol separates to locally from the gasoline, resulting in a non-homogenous mixture. This causes the engine to run erratically due to the large air-fuel ratio difference between the two fuels.

3. Write the sources for methanol?

Methanol can be obtained from many sources, both fossil and renewable. These include coal, petroleum, natural gas, biomass, wood landfills and even the ocean.

4. Write the source for ethanol?

Ethanol can be made from ethylene (or) from fermentation of grains and sugar. Much of it is made from sugarcane, sugarbeets, and even cellulose (wood and paper).

5. What are the techniques of using alcohol in diesel engine fuel?

The techniques of using alcohol in diesel engine are:

1. Alcohol diesel emulsions.
2. Dual fuel injection.
3. Alcohol fumigation.
4. Surface ignition of alcohols.

6. What are the methods are adopted for induction of alcohol into intake manifold?

The methods are adopted for induction of alcohol into intake manifold micro fog unit, pneumatic spray nozzle, vaporizer, carburetor and fuel injector.

7. List the advantages of hydrogen as an IC engine?

Advantages

1. Low emissions.
2. Fuel availability.
3. Fuel leakage to environment is not a pollutant
4. High energy content per volume when stored as a liquid.

8. List the disadvantages of using hydrogen as a fuel?

Disadvantages

- Difficult to re fuel.
- Fuel cost would be high at present day's technology and availability.
- Poor engine volumetric efficiency.
- High NOx emission because of high flame.

9. Write the methods for hydrogen can be used in SI engines?

Hydrogen can be used in SI engines by three methods

- By manifold induction
- By direct introduction of hydrogen into the cylinder.
- By supplementing gasoline.

10. List the advantages and disadvantages of natural gas?

Advantages:

- Octane number is around 120, which makes it a very good SI engines fuel.
- Low engine emissions
- Fuel is fairly abundant worldwide.

Disadvantages:

- Low energy density resulting in low engine performance.
- Low engine volumetric efficiency because it is a gaseous fuel.
- Refueling is a slow process.

11. Write the two types of LPG used in automobiles engine?

Two type of LPG used in automobile engines:

One is propane and the other is butane, sometimes in mixture of propane and butane is used as LPG in auto mobile engine.

12. What are the advantages of LPG?

- LPG mixes with air at all temperatures.
- LPG has high antiknock characteristics.
- There is no crack case dilution, because the fuel is in the form of vapor.

13. Write the disadvantages of LPG?

- A special fuel feed system is required for liquid petroleum gas.
- A good cooling system is quite necessary.
- The vehicle weight is increased due to the use of heavy pressure cylinder for storing LPG.

14. Write the improvements required for the LPG vehicle in future?

- Effort must be made to have more LPG filling stations at convenient locations, so that LPG tank can be filled up easily.
- Safety devices are to be introduced to prevent accidents due to explosion of gas cylinders (or) Leakage in the gas pipes.

15. Compare the petrol and LPG?

PETROL

Octane rating of petrol is 81

Petrol has odours

In order to increase octane number

LIQUID PETROLEUM GAS

Octane rating of LPG is 110.

LPG is odourless.

LPG is lead free with high Octane number.

UNIT-V

1. What is lean burn engine?

Lean burn engine is a lay out of Otto cycle engine designed to permit the combustion of lean air fuel mixture and to obtain simultaneously low emission values as high fuel economy. It is designed to operate effectively in the air fuel ratio **14:1-16:1** to **20:1-22:1**. When the lean compression ratio, combustion chamber shape, ignition system, the lean limit are successfully optimized, the engine is referred to as a lean burn engine.

2. Why lean mixture is preferred in SI engine?

Lean mixture is preferred in SI engine because of the following facts:

- Lower pollutants.
- Good fuel economy.
- Heat transfer losses to the cooling medium are reduced because of lower peak temperatures.
- Since lean mixture are less prone to knocking.

3. What are the modifications to be made to convert an existing engine as a lean burn engine?

The modifications to be made to convert an existing engine as a lean burn engine are:

- Increasing the compression ratio of the engine to accurate flame propagation.
- Increasing the swirl and turbulence of the mixture in order to increase flame speed.
- Catalytic activation of the charge in the combustion chamber.

4. How the stratified charge engine can be characterised?

The stratified charge engine can be characterised by the following features:

- Relatively high compression ratio
- Ability of direct cylinder fuel injection variations to run unthrottled.
- Stratification of the charge mixture into distinctly different rich and lean air fuel ratios.

5. List the advantages of the stratified charge engine.

The advantages of the stratified charge engines are:

Low octane fuels (cheaper fuels) can be used at higher compression ratios.

- Load control can be achieved without air throttling
- Quiet in operation.
- Multi fuels give more or less equal performance.

6. What are the main disadvantages of the stratified charge engine?

The main disadvantages of the stratified charge engines are:

- Maximum output (from the air in the cylinder (i.e.) complete utilization of air) is not achieved.
- The added cost of the injection/modified combustion systems.
- Added complication of injection and spark ignition systems.

7. Write short notes on plasma jet ignition system.

The plasma jet ignition system uses a plasma jet spark plug. This system can be considered as a form of electrical torch ignition, since the ignition source is hot jet plasma which project well away from the spark plug. The plasma jet ignition sources is turbulent and electrodeless, both desirable features for igniting marginal mixtures.

8. What are the factors that influence the operation of the plasma jet plug?

The factors that can influence the operation of the plasma jet plug are the amount of the applied electrical energy, the rate of energy delivery, the cavity volume, the cavity dimensions, the orifice size, the ambient gas pressure and the quantity of fuel present in the cavity.

9. What are the reasons for automotive engines equipped with gasoline injection system?

Some of the recent automotive engines are equipped with gasoline injection system, instead of a carburetion for the reasons: (1) To have uniform distribution of fuel in a multi cylinder engine. (2) To improve breathing capacity (i.e.) volumetric efficiency. (3) To reduce or eliminate detonation.

10. What are the types of injection systems?

1. Gasoline Direct Injection (GDI) in to the cylinder
2. Port injection (a) timed (b) continuous
3. Manifold injection

11. What are the objective of the fuel injection system?

The objectives of the fuel injection system are to meter, atomize and uniformly distribute the fuel throughout the air mass in the cylinder.

12. What are the components of injection system?

The components of injection system are:

1. Pumping element
2. Metering element
3. Mixing element
4. Mixture control
5. Timing control

13. Write notes on continuous injection system.

Continuous injection system usually has a rotary pump. The pump maintains the fuel line gauge pressure of about **0.75 to 1.5 bar**. The system injects the fuel through a nozzle located in manifold immediately down stream of the throttle plate.

14. Explain the functions of the following components.

(a) Pumping element, (b) Metering element, (c) Timing control, (d) Ambient control.

(a) Pumping element- moves the fuel from the fuel tank to the injector. This include necessary piping, filter etc.

(b) Metering element- measures and supplies the fuel at the rate demanded by load and speed conditions of the engine.

(c) Timing control- fixes the start and stop of the fuel-air mixing process.

(d) Ambient control-compensates for charges in temperature and pressure of either air or fuel that may affect the various elements of the system.

15. Write the advantages of homogeneous charge compression ignition engine?

1. Lower NO_x and particulate emissions
2. High thermal efficiency

16. What are the fuels used in HCCI engines?

Diesel , gasoline , methanol , natural gas and hydrogen

17. List the disadvantages of homogeneous charge compression ignition engine?

- The major problem is controlling the ignition timing over a wide load and speed.
- Power density is limited by combustion noise and high peak pressure.