Course Code: 2040315 **Roll No:** **MLRS-R20**

MARRI LAXMAN REDDY
INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
(Approved by AICTE, New Delhi & Affiliated to JNTUH, Hyderabad)
Accredited by NBA and NAAC with 'A' Grade & Recognized Under Section2(f) & 12(B)of the UGC act,1956

II B.Tech II Sem Regular End Examination, July 2022

Thermal Engineering – I

(MECH)

Time: 3 Hours. **Max. Marks: 70**

Note: 1. Question paper consists: Part-A and Part-B.
2. In Part – A, answer all questions which carries 20 marks.
3. In Part – B, answer any one question from each unit.
Each question carries 10 marks and may have a, b as sub questions.

PART- A

(10*2 Marks = 20 Marks)

1.	a)	Write the list the major losses in the actual engine.	2M	CO1	BL1
	b)	Write the classification of fuels and give examples for each type.	2M	CO1	BL1
	c)	What is the need of cooling system in IC engines?	2M	CO2	BL1
	d)	What are the functions of lubricant in an IC engine?	2M	CO2	BL1
	e)	What is pre-ignition? Discuss its ill effects on performance.	2M	CO3	BL1
	f)	What is the need of air movement in C.I. Engine combustion chamber? Explain.	2M	CO3	BL1
	g)	How do you measure air intake into an engine cylinder.	2M	CO4	BL1
	h)	Draw a model heat balance sheet.	2M	CO4	BL1
	i)	What modifications are required to use biogas in SI Engine?	2M	CO5	BL1
	j)	Write a note on fuel cell powered vehicle.	2M	CO5	BL1

PART- B

(10*5 Marks = 50 Marks)

2	a)	Draw the schematic diagram of two S.I. Engine and explain its working	5M	CO1	BL4
	b)	Draw the valve timing diagrams of ideal and actual four stroke S.I engine and discuss the salient features?	5M	CO1	BL2
		OR			
3		What are the major differences between S.I. Engine and C.I. Engine? Explain them with suitable examples	10M	CO1	BL4
4	a)	Differentiate between Magneto ignition system with battery coil ignition system.	5M	CO2	BL2
	b)	Explain the operation of splash lubrication system with suitable diagram.	5M	CO2	BL4
		OR			

5		Why lubrication is necessary in I.C. Engine components? Explain different methods of lubrication system	10M	CO2	BL4
6	a)	What is detonation in C.I. Engine? Explain the phenomenon of detonation and its ill effects on engine performance.	5M	CO3	BL4
	b)	Explain the influence of different operating parameters on ignition delay during combustion process in C.I. Engine.	5M	CO3	BL4
		OR			
7		Explain different stages of combustion in S.I.Engine along with p-θ diagram.	10M	CO3	BL4
8	a)	Explain Willaan's line method of determination of frictional power and explain why this method is not used for petrol engines.	5M	CO4	BL4
	b)	Draw the schematic diagram of prony brake and rope brake dynamometers and explain their working principles.	5M	CO4	BL4
		OR			
9		A four stroke petrol engine with a compression ratio of 6.5 to 1 and total piston displacement of 5.2×10^{-3} m^3 develops 100 kW brake power and consumes 33 kg of petrol per hour of calorific value 44300 kJ/kg at 3000 rpm. Find: i) Brake mean effective pressure ii) Brake thermal efficiency iii) Air standard efficiency ($\gamma = 1.4$); and iv) Air-fuel ratio by mass. Assume a volumetric efficiency of 80 %. One kg of petrol vapour occupies 0.26 m^3 at 1.013 bar and 15^{0}C. Take R for air 287 J/kg K.	10M	CO4	BL3
10	a)	What are various hybrid eclectic vehicle drive trains? Explain in detail.	5M	CO5	BL4
	b)	Write a note on high energy and power density batteries.	5M	CO5	BL1
		OR			
11		What is the need for alternate fuels? Discuss their availability, merits and demerits.	10M	CO5	BL2

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EXAMINATION BRANCH

Academic Year	2021-22
Year & Semester	II - II
Regulation	R-20
Branch	Mechanical
Course Code	20A0315
Course Name	Thermal Engineering - I
Course Faculty's	K.V. Raghavulu
Course Moderator	K.V. Raghavulu
Date of Exam	18/7/2022
Reporting Time & Sign	8:30 &

KEY PAPER

QNO	ANSWER	MARKS
	PART A	
1 Q:		
Ans:	→ Frictional losses	1M
	→ Heat loss of energy in exhaust gases	1M
	→ loss of energy in cooling water circulation	
	→ Radiation losses.	
1 B:		
Ans:	classification of fuels	
	1). liquid fuels eg: Petrol, Diesel	2M
	2). solid fuels eg: coal	
	3) gaseous fuels, CNG, NG, LNG	

QNO	ANSWER	MARKS
1C: Ans: =	→ cooling system is used to Reduces the Heat → It's used for smooth running of operation → It prevent the damage of the parts → To prevent uneven expansion of piston → To prevent burning of lubricating oil	2M
1D: =	– To minimize the friction b/w moving surfaces in contact thereby increasing the power output. – To Reduce the wear b/w rubbing and bearing surfaces – To cool engine parts by removing heat – To clean surface by washing any carbon & metal particles used by wear.	1M 1M

QNO	ANSWER	MARKS

1h:

Energy supplied	KJ/min	%	Energy Distribution	KJ/min	%
i) Energy supplied to fuel	X	100	(i) Energy to BP	X_1	$\frac{X_1}{EX} \times 100$
			(ii) Energy to cooling	X_2	$\frac{X_2}{EX} \times 100$
			(iii) Energy to exhaust gas	X_3	$\frac{X_3}{EX} \times 100$
			(iv) Energy to surroundings	X_4	$\frac{X_4}{EX} \times 100$
	X	100		EX	100

2M

(i)

→ Modifications include an addition of biogas carburetor for bi-fuel mining, replacing the fuel injection system with spark ignition system, reduction of compression ratio from the original 16:1 to 8:1 using a cylinder head spacer. and modification the turbo charger was gate so the boost pressure can be adjusted

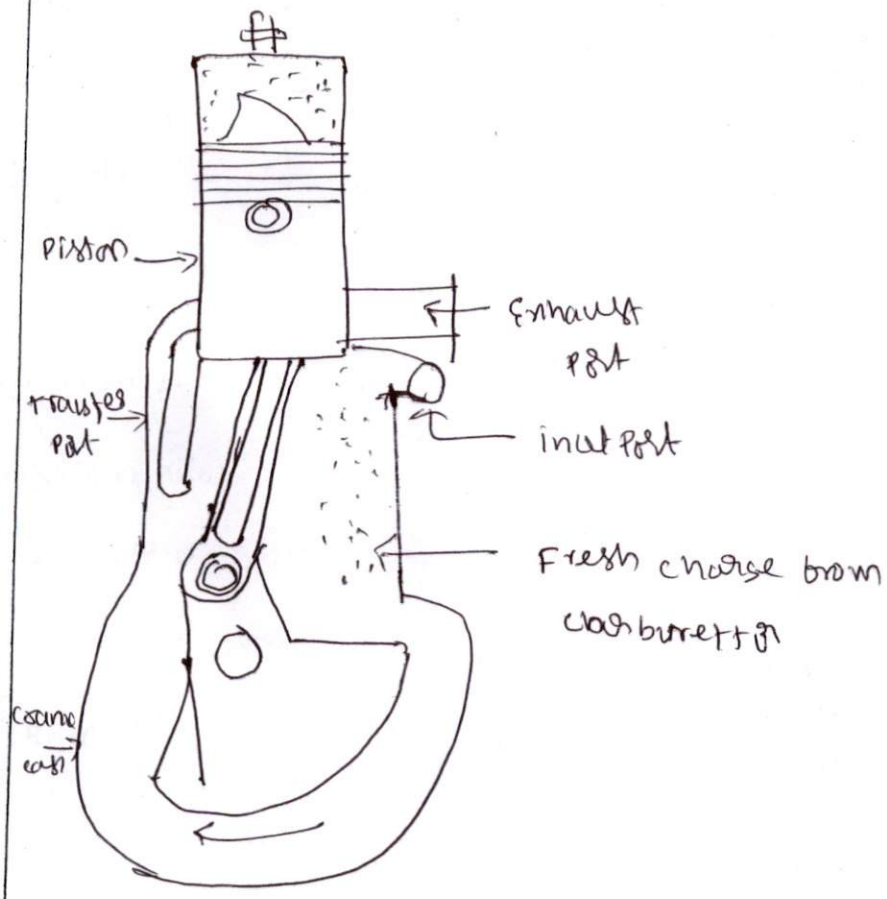
2M

(ii)

(J): Fuel cell: Fuel cells do not store energy; Instead chemical energy is converted into electricity. An external source of hydrogen and oxygen are fed to the fuel cell.

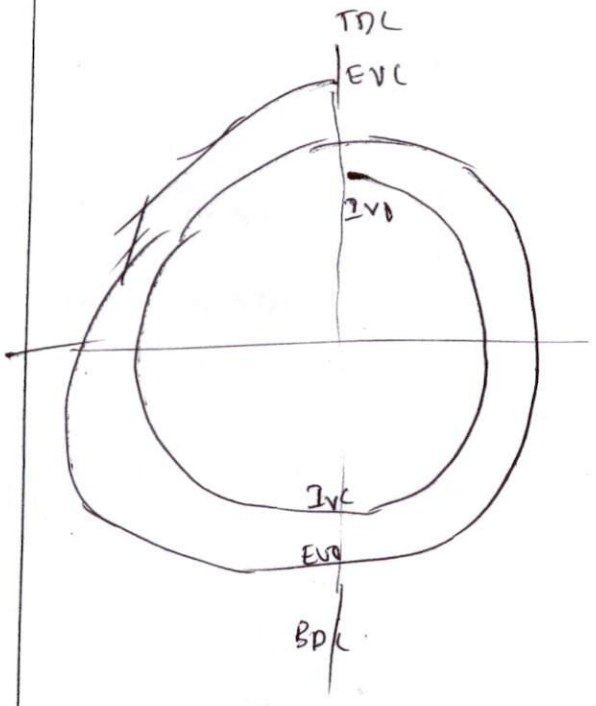
2M

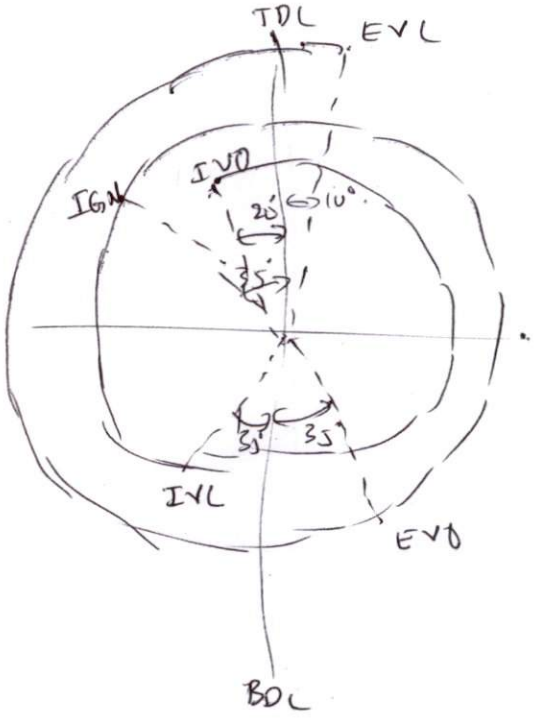
QNO	ANSWER	MARKS
'e'	→ It's a phenomenon associate with abnormal combustion. the self ignition of the charge by some hot surface within the cylinder before the passage of spark is called pre ignition.	2M
'f'	Air movement in combustion chamber is usually termed as 'turbelence'. it helps to → distribute the fuel and mix with air → Assist combustion and reduce afterburning	2M
'g'	→ The satisfactory measurement of air consumption can be achieved by airbox method. The arrangement to measure airflow rate to the engine. The airinlet manifold is connected to a large airbox with an orifice at it's inlet. the air in box assumed constant and is left than the time the swept volume of engine.	2M

QNO	ANSWER	MARKS
2(a)	 2-stroke petrol Engine → the operation of two-stroke petrol Engine is shown in above fig. due to upward stroke of the piston partial vaccum is created in crankcase, inlet port is uncovered by piston, and charge consisting a mixture of air and petrol vapour from the carburettor	2M 3M

QNO	ANSWER	MARKS
	is sucked into the crankcase. For this reason, the crankcase of 2-stroke engine is made gas tight. the upward stroke of the piston causes compression of the previously available charge inside the cylinder.	
2b: =	In theoretical analysis of engine cycle, it has been assumed that the inlet and exhaust valves open & close instantly, and also spark takes place at engine dead centres. But in actual practice the inlet valve is opened before TDC by 10 to 25 degrees of crank angle, and closed from 25 to 45° after bottom dead centre. In order to release the exhaust gases, the exhaust gas valve begins to open 30 to 55 degrees before BDC and closes 10 to 20 degrees after TDC. The charge is ignited with spark plug when the crank is at 20 to 35 degree from TDC. A typical valve timing diagram of 4-stroke SI Engine is shown in below.	2M

QNO	ANSWER	MARKS





3M

38.

criterion	SI Engine	CI engine
Basic cycle	otto	Diesel
Fuel used	petrol, gatrow	Diesel, heavy oil
compression ratio	10:1	16:1 to 22:1
Ignition / charge	due to spark	self ignition
thermal Efficiency	low	high

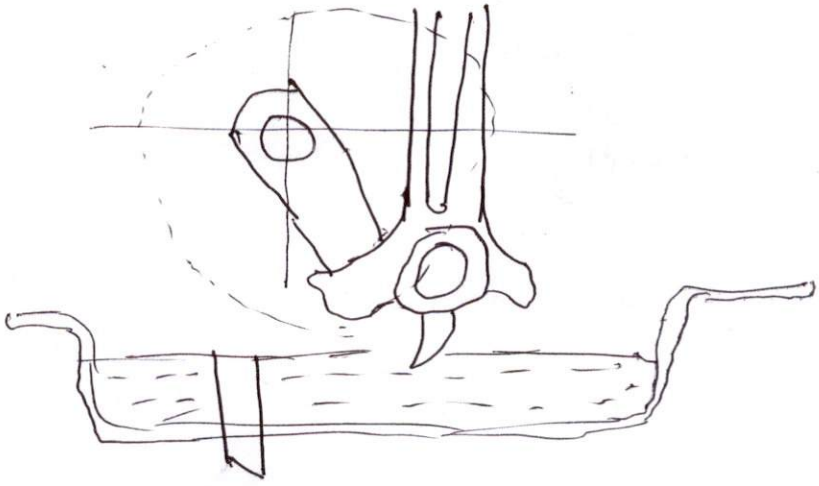
2M

QNO	ANSWER			MARKS
	weight	low	high	2M
	cost	initial cost is low, maintenance cost is high	initial cost is high & maintenance low	
	Application	scooters, motorcycles, cars, buses	tractors, buses.	

4(a)

Ans:

criterion	Battery ignition system	magneto ignition system	
source of energy	Battery	magneto	5M
maintenance	costly	cheap.	
quality of spark	Good	poor	
Efficiency	Decreases as the speed increases	Increases as the speed decreases	
use	cars & light trucks	cars & two wheelers	

QNO	ANSWER	MARKS
4b'		3M
	→ the splash lubrication system is employed for small four stroke engines. In this case parts are lubricated by oil thrown by a small projection at the big end of connecting rod.	2M
5a'	During the operation, the rubbing surface of engine parts wears, and there will be power loss due to friction. it's necessary to lubricate the engine parts i.e., to introduce lubricants b/w the surfaces which are in contact and in relative motion.	2M

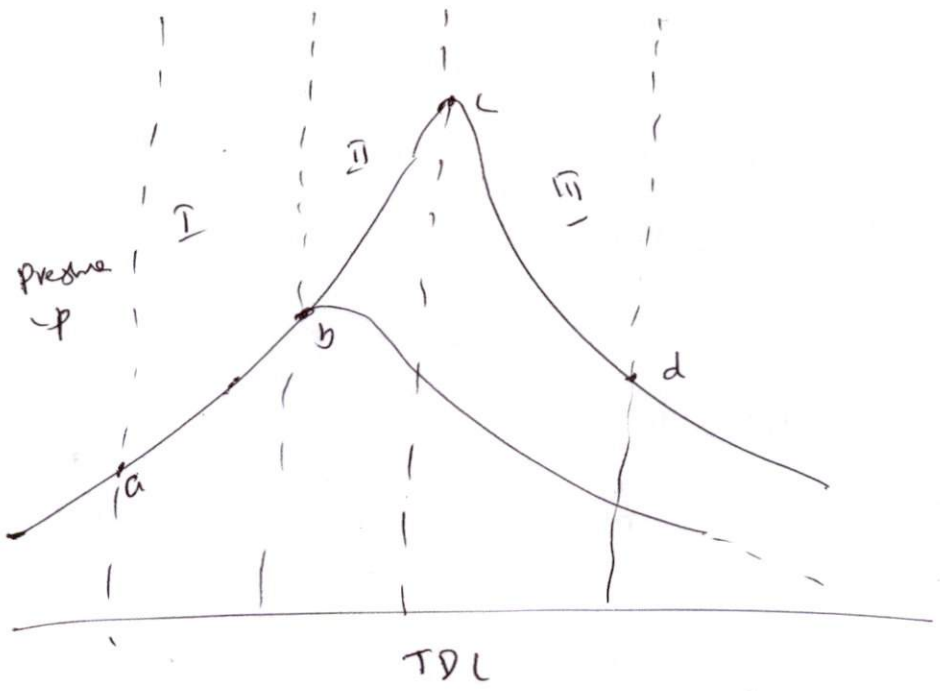
QNO	ANSWER	MARKS
	The effectiveness of engine lubrication plays an important role in the performance of engine. the functions of lubricants are: - to minimize the friction - to Reduce the wear - to cool engine parts - to clean surface by washing. methods: (1) mist lubrication (2) wet sump lubrication (a) splash (b) splash and pressure (c) pressure fed (3) dry sump lubrication system.	5 M 3 M

QNO	ANSWER	MARKS
6'a'		
Ans:	The abnormal combustion of the end gas take place instantaneously giving rise to a serve pressure wave. this produce high pitched audible sound which is called detonation.	1m
	Effects of engine variable on detonation:	
	① Fuel characteristics.	
	② condition of cylinder charge	
	③ compression ratio	
	④ Ignition	3m
	⑤ combustion chamber	
	⑥ Engine speed.	
6'b'	The time duration between initiation of spark and commencement of combustion i.e. period 'ab' is called Ignition lag. The Effects of engine variables on Ignition lag are discussed below.	2m

QNO	ANSWER	MARKS
	1. compressed gas temperature & pressure: the rate of chemical reaction increase rapidly at high temperature. therefore ignition lag decrease by increasing temp & pressure of the air fuel mixture. 2. Fuel: the ignition lag depends on the chemical Nature of fuel. Ignition lag is large with the fuel having higher self ignition temp. 3. Air fuel ratio: ignition lag is shorter for the mixture ratio which is slightly richer than the stoichiometric value 4. Electric gap: Development of stable nuclei flame depends on Electrode gap	3M

QNO	ANSWER	MARKS

(7):



4m

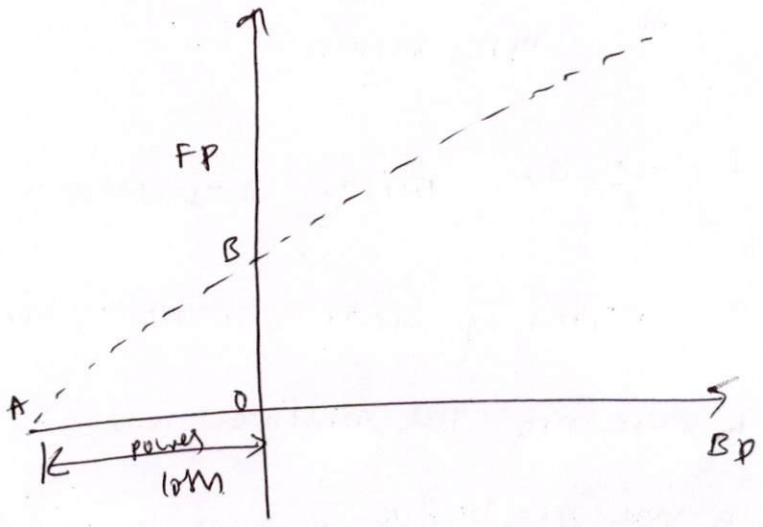
I: Ignition lag

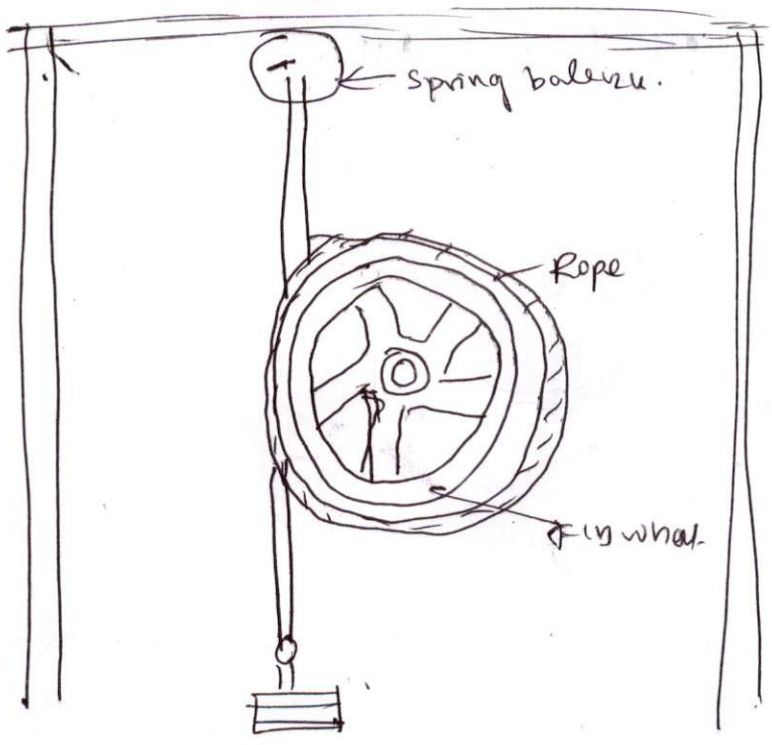
II: propagation of flame

III: After burning.

I stage - ab: During compression stroke air-fuel mixture is ignited by spark. point 'a' represents the passage of spark into the mixture and b is the point at which pressure rise begins & combustion starts.

2m

QNO	ANSWER	MARKS
	II stage bc: At point 'b' pressure rise begins and attains peak pressure at c. From point b the combustion curve deviates from the motoring curve. During the second stage the flame propagates throughout the combustion chamber.	2M
	III stage cd: Almost at point 'c' represents the completion of flame travel, some fuel may burn after point c during the expansion stroke.	2M
8 a)		2M

QNO	ANSWER	MARKS
	In willan's line method, the engine is run at constant speed by djusting the fuel supply during test. load is reduced in steps and corresponding BP & fuel consumption readings are recorded. A graph is drawn taking fuel consumption on y-axis & BP on x-axis.	3M
8b:	Prony brake dynamometer: 	3M
	→ It consists of rope wrapped around the fly wheel of the engine. one end of the rope is attached to	

QNO	ANSWER	MARKS

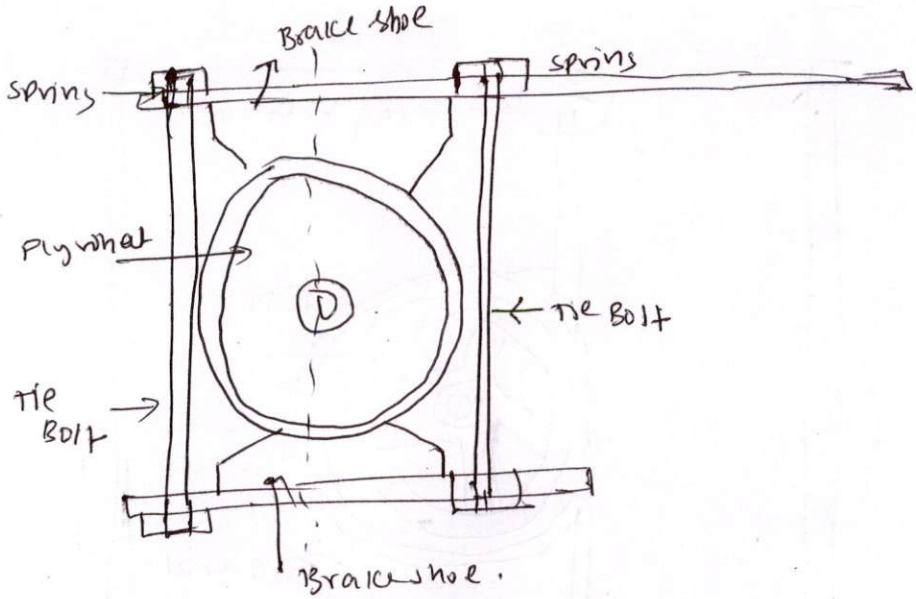
Spring balance, and other end to a brake load 'W'. The torque that opposing the engine brake is provided by the net brake load.

the expression for Bp using brake test

$$B_p = W - S\left(\frac{D+d}{2}\right)$$

2m

Prony Brake dynometer:



→ A prony brake contains brake shoes which are clamped on to the fly wheel rim by means of tie bolts, a load arm & load bar Extended from the top of the brake, and load attached to the bar.

QNO	ANSWER	MARKS
9:	Compression ratio r_c = 6.5:1 Piston displacement = $5.2 \times 10^{-3}\ m^3$ Power output Bp = 150 KW m_f = 33 kg/hr CV = 44300 N = 3000 rpm η_v = 80%. volume of petrol = $0.26\ m^3$ Pressure = 1.013 bar T_1 = 15°C. R = 287 J/kg K.	1M
	(i) Brake mean Effective Pressure: $BP = \frac{P_{bm} L a n}{60 \times 1000}$ KW $1000 = \frac{P_{bm} \times s \times n}{60 \times 1000}$	2M

QNO	ANSWER	MARKS

$$100 = \frac{P_{bm} \times 5.2 \times 10^{-3} \times 1500}{60 \times 1000}$$

$$P_{bm} = 769.23 \times 10^3 \text{ N/m}^2$$

$$\Rightarrow 7.6923\ 10^5 \text{ N/m}^2 = 7.69 \text{ bar}$$

(ii). Brake thermal Efficiency:

$$\eta_{bth} = \frac{BP \times 60}{m_f \times CV}$$

$$= \frac{100 \times 60}{0.55 \times 44300} \times 100$$

$$= 24.62\%.$$

3M

(iii). Air standard Efficiency =

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

$$= 1 - \frac{1}{(6.5)^{0.4}}$$

$$= 52.7\%.$$

3M

QNO	ANSWER	MARKS

(iv) Air fuel ratio:

Volumetric Efficiency = $\frac{\text{volume of charge admitted at NTP}}{\text{stroke volume}}$

Volume of charge admitted per cycle at NTP

$= 0.8 \times 5.2 \times 10^{-3}$

$= 4.16 \times 10^{-3}$ per cycle.

mass of petrol per cycle = $m_f = \frac{0.55}{1500}$

$= 3.67 \times 10^{-4}$ kg/cycle.

volume of petrol per kg at NTP

$V_2 = \frac{P_1 V_1}{P_2} \times \frac{V_2}{T_1}$

$= \frac{0.20 \times 273}{288}$

$= 0.240 \text{ m}^3/\text{kg}$.

Volume of petrol = $0.240 \times 3.67 \times 10^{-4}$

$= 0.903 \times 10^{-4} \text{ m}^3/\text{cycle}$

Volume of air admitted per cycle = $\frac{mRT}{P} = 0.733 \text{ m}$

4M

QNO	ANSWER	MARKS

volume of charge admitted per cycle = volume of petrol at NTP + volume of air at NTP

$4.10 \times 10^{-3} = 0.903 \times 10^{-4} + 0.733 m$

$m = 5.26 \times 10^{-3} kg$

Air fuel ratio = $\frac{m}{m_f}$

$= \frac{5.265 \times 10^{-3}}{3.67 \times 10^{-4}}$

$= 14.345$

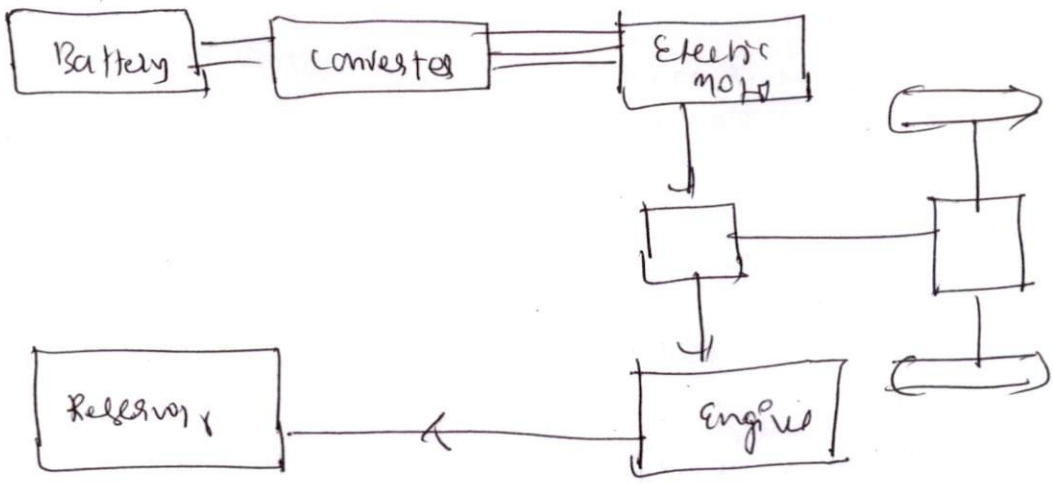
10: (a):

- Hybrid vehicle train / drive train transmit power to the driving wheels for hybrid vehicles. A hybrid vehicle has multiple forms of motive power.

- Parallel Hybrid train:

* parallel hybrid system have both an internal combustion engine and an electric motor that can both individually drive the or both coupled by joint train.

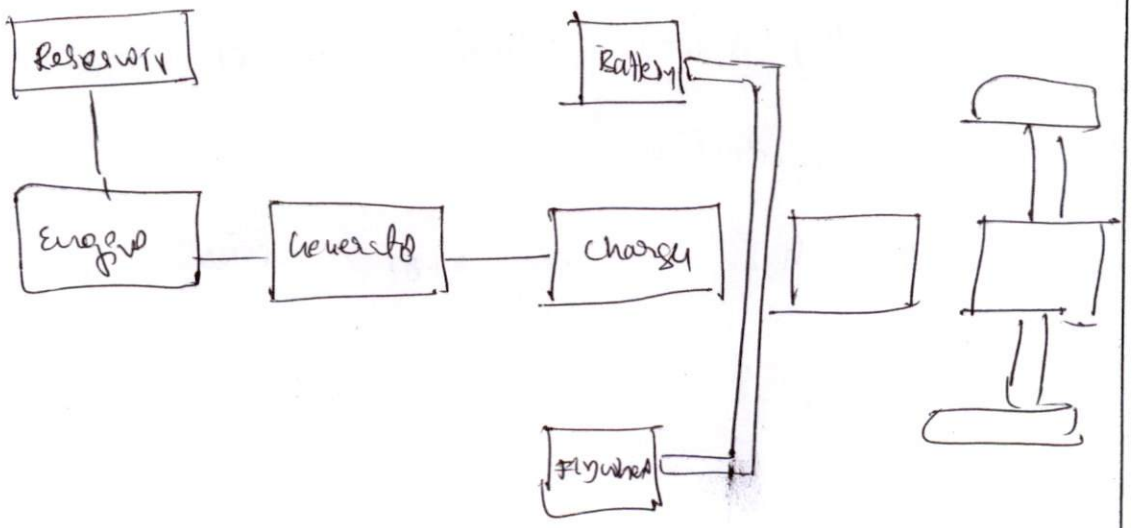
QNO	ANSWER	MARKS



2M

Parallel hybrid drive train

→ Serial hybrid are also refferred to as extented range electric vehicles.



2M

Serial hybrid drive train

QNO	ANSWER	MARKS
	→ Electric transmission has been available as an alternative to conventional mechanical transmission since 1993. Typically mechanical transmissions impose many penalties, including weight, bulk, noise, cost, complexity etc.	
10b)	With Energy & Power density Batteries:	
	→ Essentially, the main difference between energy density and power density is the batteries with a higher energy density will be able to store large amounts of energy, while batteries with a higher power density will be able to release higher Amounts of Energy at a faster rate.	2M
	→ Energy density is a measure of how much energy a battery can hold. the higher the energy density the longer the runtime will be. Lithium ion with Cobalt cathodes offer the highest energy density	2M

QNO	ANSWER	MARKS
(ii).	Need of Alternative fuels: → For use in motor vehicles to delivers direct propulsion, → less damaging to the environment than conventional fuels, and prescribed by regulation. → Including, without limiting the generality of the forgoing, Ethanol, methanol, propane gas, natural gas, hydrogen or electricity when used as a sole source of direct propulsion energy. Availability: → The availability of alternative fuels varies depending on the type of fuel & your location. → Some alternative fuels, such as biodiesel and Ethanol, can be made from locally-sourced materials.	2M 3M

QNO	ANSWER	MARKS

others, such as hydrogen & liquid nitrogen, are readily available from factories and other sources.

Merits:

- you get to solve limited Resources.
- Alternative fuel sources are more cost efficient
- they are more effective and longer lasting.
- the emissions are fewer and cleaner
- turn to Alternative Energy source today.

3M

De merits:

- High cost, unfortunately, the technologies that utilize alternative sources of energy remain relatively expensive.

2M