

PART - A

Comprehensive Examination

Second Semester 2022-2023

Name:

Id:

Birla Institute of Technology and Science, Pilani
ME F441: Automotive Vehicles

Close Book 12 Marks

09:30-10:30 AM, 20/05/2023

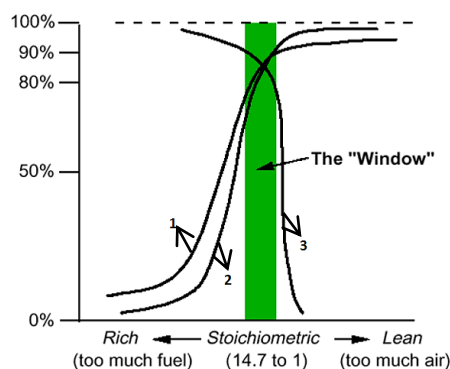
- Instructions:** 1. Please write concisely, legibly and final answers should be clearly marked.
2. Draw neat labelled diagrams wherever necessary.
3. All questions are compulsory.

Q1. Match items of List I with the most correct items of List II:

[2M]

List I	List II
MacPherson strut	Hotchkiss Suspensions
Independent suspension	Suspension system that uses a spring and shock absorber in a single unit
Multi-link suspension	Suspension system that allows each wheel to move independently
Solid axle suspension	Suspension system that uses a linkage of arms and rods to connect the wheels

Q2. Shown below is the variation in conversion efficiency with equivalence ratio of various emissions from a three-way catalytic converter. Identify the different emissions numbered 1 to 3 and give an explanation for the variation. [2.5M]



Q3. Answer the following multiple choice questions (only one option is correct and no negative marking): [2.5M]

(i) What is the function of the clutch in a car?

- (a) To regulate the fuel supply (b) To change the gears (c) To start the engine (d) To engage and disengage the engine from the transmission

(ii) There are two statements marked as Assertion (A) and Reason (R). Mark your answer as per the codes provided below:

Assertion (A): Higher is the temperature of the Gasoline engines, higher will be the thermal efficiency.

Reason (R): Gasoline engines are heat engines and hence their efficiency is linked to Carnot cycle efficiency.

- (a) Both A and R are true and R is the correct explanation of A (b) Both A and R are true but R is not the correct explanation of A (c) A is true but R is false (d) A is false but R is true (e) Both A and R are false

(iii) Which of the following is *not* a type of car body style?

- (a) Sedan (b) Convertible (c) Monocoque (d) Station wagon

(iv) What is the purpose of a car's transmission fluid?

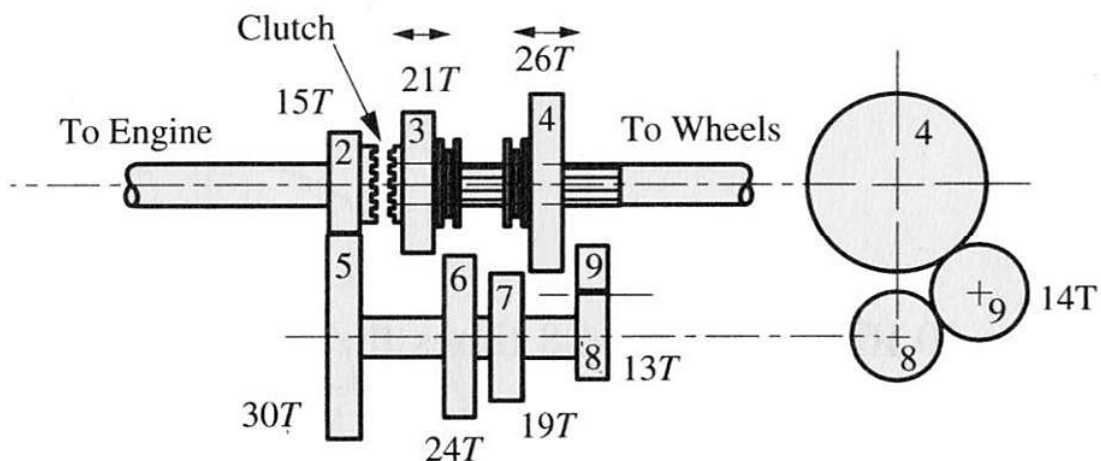
- (a) To provide power to the transmission (b) To regulate servo response (c) To cool the transmission (d) To lubricate and cool the transmission

(v) What is the role of the lambda sensor in a car's exhaust system?

- (a) To measure the amount of nitrogen oxide in the exhaust gases (b) To measure the amount of carbon dioxide in the exhaust gases (c) To measure the amount of oxygen in the exhaust gases (d) All of the above

Q4. What is the classification of Hybrid Electric Vehicles by Drive Train Structure? Explain each of them using appropriate schematic diagrams. [2.5M]

Q5. Identify the type of transmission shown below in the figure. How many forward gear ratios are offered by this transmission? Calculate all the gear ratios including reverse. [2.5M]



PART - B
Comprehensive Examination
Second Semester 2022-2023

Name:

Id:

Birla Institute of Technology and Science, Pilani
ME F441: Automotive Vehicles

Open Book 28 Marks

10:30 AM-12:30 PM, 20/05/2023

- Instructions:** 1. Please write concisely and legibly. Final answers should be clearly marked.
2. Draw neat labelled diagrams wherever necessary.
3. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
4. Assumptions made if any, should be stated clearly at the beginning of your answer.
5. All questions are compulsory.
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Q1. An Ackermann steering system is to be designed for an automobile of wheel base 2450 mm and wheel track 1735 mm. The design requirements say that the turning circle radius and angle (to the centre line of the car) of outer wheel stub axle should not exceed 4800 mm and 31.5° respectively. The length of each track arm is 200 mm. Determine the followings:

- a) Maximum angle (to the centre line of the car) of inner wheel stub axle for true rolling condition of all wheels. [2M]
- b) The length of all the link in the Ackermann steering mechanism. Draw a schematic diagram representing the system. [4M]
- c) Does the design offer true rolling condition for all the other steering angles? Explain your reasoning. [1M]

Q2. A vehicle weighing 1200 kg is tested on a flat surface for braking efficiency. It was found that under the maximum braking condition on all four wheels, the vehicle comes to rest from a speed of 56 km/h in a distance of 25.2 m. The vehicle details are as following: wheelbase = 2.8 m, distance of CG behind the front axle = 1.35 m and distance of CG above the ground level = 0.81 m.

- a) Under this condition, calculate the coefficient of adhesion between the tyre and the road. [3M]
- b) If the vehicle moves down a hill of gradient 1 in 15 and braked on the rear wheels only, calculate the distance required to bring the vehicle to rest. [3M]
- c) Draw the schematic diagram showing various forces. [1M]

Q3. A commercial vehicle truck has a curb weight of 78480 N. The engine specifications say that the truck can deliver max power of 155.5 kW@2520 rpm and maximum torque of 350.3 Nm@1540 rpm. The truck has a four speed manual transmission with the following gear ratios and efficiencies: 1st gear 5.1@82%, 2nd gear 4.2@80%, third gear 2.9@78%, and 4th gear 1.2@77%; the rear axle ratio is 6.2. The frontal area and effective wheel diameter of the truck are 7.2 m² and 1.25 m respectively. Assuming coefficients of resistances remain constant during entire range of vehicle operation, the coefficient of rolling resistance and the coefficient of air resistance are estimated to be 0.045 and 0.038 respectively. Based on the given data, calculate the followings:

- a) The maximum speed of the vehicle (in km/h) in a flat road. [2M]
- b) The maximum grades which the vehicle can climb. [2M]
- c) The maximum load this truck can carry under the road grades of 1 in 24. [2M]
- d) The maximum vehicle acceleration at vehicle speed of 30 km/h on a flat road with fully loaded truck. Ignore increase in weight of the vehicle during acceleration. [2M]

Hint: In calculation of air resistance ($K_a AV^2$), velocity (V) should be taken in km/h.

Q4. A gasoline vehicle having four-cylinder, four-stroke SI engine is being tested for performance. It has cylinder bore 68.5 mm and stroke 72.0 mm. The engine runs at 6000 rpm with air-fuel ratio 15:1 and develops indicated mean effective pressure 12 bar. An air flow meter installed at the inlet manifold reads 52.55 g/s during the engine operation.

Following values are available for the analysis: Calorific value of gasoline is 44,000 kJ/kg. Mechanical efficiency is 0.85 and combustion efficiency is 0.97. Pressure and temperature of air are 101.3 kPa and 30 °C respectively. Determine:

- a) Engine capacity (cc) [1M]
- b) Indicated power (kW) [1M]
- c) Volumetric efficiency (%) [1M]
- d) Heat supplied by fuel (kJ/s) [1M]
- e) Brake thermal efficiency (%) [1M]
- f) Brake specific fuel consumption (kg/kWh) [1M]
