Reg. No.

## MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal)

PIREDBY

## SECOND SEMESTER M.TECH. (AUTOMOBILE ENGINEERING) END SEMESTER EXAMINATIONS, APRIL- MAY 2024

## **ADVANCED AUTOMOTIVE DRIVETRAIN SYSTEMS [AAE 5213]**

**REVISED CREDIT SYSTEM** 

| Time: 3  | 3 Hours                                    | Date: 30 April 2024                         | Мах   | . Mar | ks: 50 |
|----------|--|---|-------|-------|--------|
| Instruct | tions to Candidates:                       |   |       |       |        |
| •        | Answer <b>ALL</b> the questions.           |   |       |       |        |
| •        | Missing data may be suitab                 | ly assumed.                                 |       |       |        |
| Q.NO     | Questions                                  |   | Marks | CO    | BTL    |
| 1A.      | A manual transmission used                 | for a vehicle with data given below has six | (5)   | 1     | 4      |
|          | forward speeds and the gear ra             |   |       |       |        |
|          | gear (1.51), 4th gear (1.07), 5th          |   |       |       |        |
|          | consumption is 275 gr/(kW.hr               |   |       |       |        |
|          | and 5 <sup>th</sup> gear. Consider the den |   |       |       |        |
|          | following data:                            |   |       |       |        |
|          | Front axle weight                          | : 800 kg                                    |       |       |        |
|          | Centre of gravity height                   | : 45 cm                                     |       |       |        |
|          | Air drag coefficient                       | : 0.32                                      |       |       |        |
|          | Tire radius                                | : 30 cm                                     |       |       |        |
|          | Powertrain efficiency                      | : 0.94                                      |       |       |        |
|          | Max. power @6000 RPM                       | : 138 HP                                    |       |       |        |
|          | Rear axle weight                           | : 700 kg                                    |       |       |        |
|          | Wheel base                                 | : 2600 cm.                                  |       |       |        |
|          | Frontal projected area                     | $: 2.2 \text{ m}^2$                         |       |       |        |
|          | Roll resistance coefficient                | : 0.018                                     |       |       |        |
|          | Traction coefficient                       | : 1.0                                       |       |       |        |
|          | Max. torque @4500 RPM                      | : 80 Nm                                     |       |       |        |
|          | a) The engine RPM drops by                 |   |       |       |        |
|          | vehicle speed of 72 km/h.                  |   |       |       |        |
|          | b) Determine the engine torq               |   |       |       |        |
|          | cruising at a constant spee                |   |       |       |        |

5th gears respectively.

c) Determine the fuel economy in litres per 100 km for the conditions in (b).

The equations of gears are;

|              | Gear ratio $(i_a) = \frac{\Delta \omega (in RPM)}{\omega_W (i_{gl} - i_{gh})}$   |     |   |   |
|--------------|--|-----|---|---|
|              | Resistance ( <i>R</i> ) = $fW + 0.208554 \times C_D Av^2$ in kgf   |     |   |   |
|              | Engine power $=\frac{Rv}{\eta}g$ in J/s  |     |   |   |
|              | Angular speed corresponding to gear i, $\omega_e{}^{(i)} = i_i i_a \omega_w$   |     |   |   |
|              | $\omega_w = v/r$   |     |   |   |
|              | Torque corresponding to gear i, $T_e^{(i)} = \frac{Rr}{\eta i_i i_a}$  |     |   |   |
| 1 <b>B</b> . | Analyze the benefits of using hydrostatic transmission mechanism over hydrokinetic transmission units like fluid coupling and torque converter.  | (3) | 3 | 4 |
| 1C.          | Suggest a solution to the low load capacity of a single plate clutch.  | (2) | 2 | 4 |
| 2A.          | Illustrate in brief the basic vehicle structure with fundamental components and the use of those.  | (5) | 1 | 3 |
| 2B.          | Explore the working, advantages and disadvantages of Dual Clutch Transmission System.  | (5) | 4 | 3 |
| 3A.          | Demonstrate the working and role of CVT in enhancing the efficiency over Automatic gearbox.  | (4) | 4 | 3 |
| 3B.          | A cone-clutch with a cone semi-angle of $12^{\circ}$ is to transmit 11.19 kW at 750 RPM. The width of the face is $1/4^{\text{th}}$ of the mean diameter and the normal pressure between the contact faces is not to exceed 8.27 x $10^4$ Pa. Allowing the coefficient of friction of 0.2, determine the main dimensions of the clutch and the axial force required. | (4) | 2 | 4 |
| 3C.          | Demonstrate the working of transfer case in a 4WD transmission vehicle.  | (2) | 1 | 3 |
| 4A.          | Classify and illustrate in brief the hydrostatic transmission unit according to the transmission ratio.  | (5) | 3 | 3 |
| 4B.          | Explore any technology that eliminates the gear overlap or interference during engagement and disengagement of gears in manual gearbox.  | (3) | 5 | 3 |
| 4C.          | Suggest any technology that improves the efficiency and efficacy of automatic transmission.  | (2) | 4 | 5 |

5A. In an automatic gearbox, single set of planetary geartrain is used, consisting central sun gear S, star shaped planet carrier C carrying 3 planet gears P, rotating between sun and annular gear (internal gear) E. The size of wheels/ gears is such that C rotates at 1/5<sup>th</sup> of the S gears. The number of teeth on sun gear is 16. Determine number of teeth on different gears.



The operation gear relations are given in table,

| <i>S</i> . | Operation   | Revolution of elements |                |                             |  |
|------------|---|------------------------|----------------|-----------------------------|--|
| No.        |   | Planet<br>carrier C    | Sun<br>wheel S | Planet<br>wheel P           | Internal gear E  |
| 1.         | Planet carrier C fixed. Sun wheel S rotates through + 1 revolution. ( <i>i.e.</i> 1 rev. anticlockwise) | 0                      | + 1            | $-\frac{T_S}{T_P}$          | $-\frac{T_S}{T_P} \times \frac{T_P}{T_E} = -\frac{T_S}{T_E}$ |
| 2.         | Multiply by x to all  | 0                      | + <i>x</i>     | $-x \times \frac{T_S}{T_P}$ | $-x \times \frac{T_S}{T_E}$                                  |
| 3.         | Add y revolution to all elements  | + y                    | x+y            | $-x\frac{T_S}{T_P}+y$       | $-x \frac{T_S}{T_E} + y$                                     |

And Pitch relation is,

$$\frac{D_S}{2} + D_P = \frac{D_E}{2}$$

5B. Briefly illustrate the components of hydraulic actuation system in a 3 (5) 5 transmission line.