

MANIPAL (A constituent unit of MAHE, Manipal)

## **II SEMESTER M.TECH. (AUTOMOBILE ENGINEERING)**

## **END SEMESTER EXAMINATIONS, APR-MAY 2019**

SUBJECT: HYBRID AND ELECTRIC VEHICLES [AAE 5282]

## REVISED CREDIT SYSTEM (07/05/2019)

Time: 3 Hours

MAX. MARKS: 50

## Instructions to Candidates:

- ✤ Answer ALL the questions.
- ✤ Missing data may be suitable assumed.
- 1A. What are the main subsystems involved in the architecture of an electric drive vehicle? Draw the layout of such an electric drive system showing the essential features. (03)
- 1B. What are the energy saving opportunities that exist in Hybrid (03)
   Electric Vehicles (HEVs) when compared to conventional vehicles? What are the limitations of HEVs?
- 1C. For a motor car, the road resistance is two percent of the weight of vehicle and air resistance= 0.083 V<sup>2</sup>, where V is the speed of vehicle in Kmph, transmission efficiency in high gear =89 %. The gross vehicle weight is 19,900 N. Find (i)The power required for (04) cruising at a top speed of 130 kmph. (ii) Power required to drive up a gradient of 1 in 5 at 45 kmph with an efficiency of 80 % in lower gear.
- 2A. With a neat sketch, illustrate the constructional details and working of a switched reluctance motor. How does the vehicle load requirements are met with such traction motors? (03)
- **2B.** Discuss the functioning of the following semiconductor devices as switches (i) GTO (ii) MOSFET. (03)
- 2C. What are the requirements of vehicle control systems? With a block diagram, explain the working of a HEV controller to meet the driver's requirement of vehicle speed. (04)
- **3A.** Illustrate with energy flow diagrams, six different modes of operations in Motor dominated series- parallel hybrid vehicles. (04)

**3B.** Differentiate the following with respect to Hybrid electric vehicles.

 (i) Motor speed ratio and Engine speed ratio (ii) Speed couplers and torque couplers (iii) Pre- transmission hybrids and posttransmission hybrids.
 (03)

- **3C.** With typical Engine speed characteristics, Discuss the effect of torque elasticity and speed ratio on gear shifting frequencies. (03)
- 4A. A motor vehicle weighs 8000 N and its engine develops 14.7 kW at 2500 RPM. At this engine speed, the road speed in top(direct) gear is 64 kmph. The bottom gear reduction is 3.5:1 and the transmission efficiency is 88% in top gear and 80% in bottom gear. the diameter of the tyres is 760 mm and the projected frontal area is 1.2 m<sup>2</sup>. Air resistance =  $K_a AV^2$  where air resistance coefficient Ka= 0.0314 N-hr<sup>2</sup>/km<sup>2</sup>-m<sup>2</sup>, V- speed of vehicle in kmph. Road resistance = 0.023W, where W-weight of the vehicle in N. Calculate (i) Speed of the vehicle on bottom gear(ii) Tractive efforts available at the wheels on top and bottom gears (iii) Gradient which the vehicle can negotiate in bottom gear(iv) The tractive force at the wheels required to start up the vehicle on the level and attaining a speed of 50 kmph in 10 (04) seconds.
- 4B. How the EVs are classified based on in- wheel drive systems?Explain their essential features with relevant sketches. (03)
- **4C.** Illustrate the broad-based procedure followed while rating the propulsion systems for electric vehicles considering the following.

(i) Initial acceleration performance (ii) Maximum speed capability (03)

- 5A. Compare Brush Less D C, Induction and Switched Reluctance (SRM) traction motors based on (i)Setting up of Rotor magnetic field (ii) Rotor material used (iii) Rotor construction (iv) Meeting the torque requirement. (04)
- 5B. Explain the constructional details and working principle of the Lithium-ion battery. Write the reactions taking place during charging and discharging of such batteries. List their advantages, disadvantages and applications. (03)
- 5C. A single epicyclic gear train has a fixed sun gear with 100 teeth and a planet gear with 50 teeth. If the arm is revolved once, adapt the tabular method to find how many times does the planet gear revolve?
  (03)