Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VII SEMESTER B.TECH. (AUTOMOBILE ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2019

SUBJECT: ELECTRIC AND HYBRID VEHICLES [AAE 4021]

REVISED CREDIT SYSTEM
(26/11/2019)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. What are the requirements of traction motors used for Electric and Hybrid vehicle propulsion? **(02)**

1B. With a circuit diagram, illustrate the working principle of switched reluctance motor propulsion systems. what are its advantages and applications? **(03)**

1C. A series electric vehicle, with a two-speed gearbox, weighs 7975 N and its traction motor develops 14.7 kW at 2500 RPM. At this motor speed, the road speed in top gear is 60 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 0.76 m and the projected frontal area is 1.12 m^2. Air resistance is modeled as $K_a AV^2$,where air resistance coefficient K_a= 0.0314 N-hr^2/km^2-m^2 , V- speed of vehicle in kmph. Road resistance is modeled as 0.023W, where W is weight of the vehicle in Newton. Calculate the following. **(05)**

i) Speed of the vehicle on bottom gear
ii) Tractive efforts available at the wheels on top and bottom gears
iii) % Grade 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 45 kmph in 10 seconds.

2A. Discuss the technical specifications of (i) Electrical propulsion system (ii) Energy storage system for Toyota Prius II Hybrid electric vehicle. **(02)**

2B. Discuss how the following Engine control strategies helpful in meeting the requirements in Hybrid Electric vehicles (i) Displacement on demand (ii) cylinder deactivation. **(03)**

2C. Find the power rating of the traction motor for an EV required to accelerate from 0-78 KMPH in 9 seconds. Assume mass of the car as 1500 kgs, rolling wheel radius as 300 mm, motor speed ratio=2, motor base speed= 1250 RPM, single gear box ratio of 1:1 in the drive line. Assume air drag coefficient=0.3, rolling resistance coefficient= 0.01, car frontal area =2 m^2, drive line efficiency= 95%, rotational factor=1.1. **(05)**

Check the adequacy of the motor for the following modes.

(i) Top speed of 120 kmph.
(ii) Moving up a gradient of 5% grade at the speed of the car corresponding to

motor's base speed.

3A. With a circuit diagram and relevant waveforms, explain the working of a boost converter. **(03)**

3B. Differentiate engine speed ratio and motor speed ratio. Discuss the effect of motor speed ratio on the transmission system design in electric vehicles. **(03)**

3C. With relevant energy flow diagrams, illustrate the following modes of operation in I C Engine dominated series- parallel hybrid vehicles. (i) Cruising (ii) Charging while driving (iii) Acceleration **(04)**

4A. Why the D C shunt motors are a better choice as traction motors when compared to D C series motors. Show their Torque- speed characteristics. **(03)**

4B. Explain with a neat sketch, the features of outer rotor in wheel drive configured systems for Electric vehicles. What are their merits and demerits? **(04)**

4C. Discuss the constructional and working principle of Li-P battery. What are its advantages, disadvantages? State any two applications. **(03)**

5A. Differentiate the induction motor and BLDC motor based on (i) Rotor construction (ii) Rotor magnetic field (iii) slip (iv) Meeting the load requirement **(03)**

5B. Find the range in miles and fuel economy of (i) Conventional vehicle (overall efficiency=13%) (ii) HEV in battery bypass mode (overall efficiency=22%) with the following. **(03)**

Driving mode: cruising at 40 mph, Gasoline in tank= 15 Gallons, Energy density of the fuel= 33.7 kWh/Gallon. Power required for cruising = 10 kW.

5C. Draw the block diagram of a vehicle system controller for hybrid electric vehicles and illustrate the energy management strategies adapted. **(04)**