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SEAT No. :

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B.E. (Automobile Engineering)

HYBRID & ELECTRIC VEHICLE

(2019 Pattern) (Semester-VIII) (416489)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Assume suitable data if necessary.***
2) ***Answer FOUR questions from the following (Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8.***

Q1) a) State any two applications of following EV motors: **[8]**

i) BLDC Motor, ii) Induction Motor,

iii) PMAC/I-PMAC Motor, iv) Switch Reluctance Motor.

b) How does 'Regeneration' in 'Electric Vehicle (EV)' take place? **[9]**

OR

Q2) a) Explain different losses in electric vehicle motors. **[8]**

b) Why internal permanent magnet (IPM) motors are preferably used in electric vehicle? **[9]**

Q3) a) Draw and explain 'Discharge Characteristics' of Li-Ion battery. **[10]**

b) Why slow charging is preferred (or fast charging is avoided) in Li-Ion battery. **[8]**

OR

Q4) a) Calculate SOC for 10 second for a pulse of 5 Amp current for following given data: **[10]**

i) Total cell capacity = 10 Watt-hr,

ii) Cell internal resistance = 30 mili-Ohms,

iii) Initial state of charge = 85%

iv) Open circuit voltage = 3.9 Volt.

b) List energy storage devices of electric vehicle & explain any one briefly. **[8]**

P.T.O.

Q5) a) What are the primary functions of Battery Management System (BMS)? **[8]**

b) What are the components of Battery Management System? **[9]**

OR

Q6) a) What is the need of Battery Thermal Management System (BTMS)? **[8]**

b) State different methods used in Battery Thermal Management System. Explain any one method with neat sketch. **[9]**

Q7) It is decided to provide equivalent 'Battery Electric Motor' combination for existing 'Hero Honda Splendor' with following specification: (1) Gross Vehicle Weight (GVW) = 205kg, (2) Maximum Speed = 85kmph, (3) Acceleration = $0.7m/s^2$ for plane road and $0.49m/s^2$ for grade road, (4) Gradability = 7º, (5) Radius of wheel = 0.292m, (6) Expected Range = 54km for EV, (7) Engine Specifications: Power = 5.9kw, Volume = 97.2cc, Max. Torque = 8.05Nm @ 6000 RPM, (8) Gear Box: Four gears with gear ratios $G_1 = 2.92$, $G_2 = 1.72$, $G_3 = 1.16$, $G_4 = 0.9$, and Final Drive Reduction = 3.5. Also assume Air Density = $1.2kg/m^3$, Coe. Of Drag = 0.65, Frontal Area = $0.23m^2$, Coe. of rolling resistance = 0.013. **Calculate:** (i) Motor Power in kW, (ii) Battery Pack Capacity in kwhr, (iii) Energy Efficiency in Watt-hour/km, (iv) Max. Vehicle Speed in kmph, and (v) EV range in km. **[18]**

OR

Q8) It is decided to design an electric 4-Wheeler with following specification: (1) Gross Vehicle Weight (GVW) = 1200kg, (2) Maximum Speed = 120kmph, (3) Acceleration = 0 to 120 kmph in 20 seconds, (4) Grade = 5º, (5) Radius of wheel = 0.31m, (6) Coe. of Drag = 0.35, (7) Gear Ratio = 9:1, (8) Air Density = $1.225kg/m^3$, (9) Front Area = $2.5\ m^2$ (10) Coe. of rolling resistance = 0.013, (11) Speed on grade road = 60 kmph, (12) Coe. of sliding friction = 0.3.

Calculate: (i) Motor Power in kW, (ii) Battery Pack Capacity in kwhr, (iii) Energy Efficiency in Watt-hour/km, (iv) Actual Max. Vehicle Speed in kmph, and (v) EV range (in km) for plane road at constant speed of 90kmph. **[18]**