UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: May 2023

Module Number: ME 5210 **Module Name: Electric and Hybrid Vehicle Engineering (C-18)**

[Three Hours]

[Answer **all questions**, each question carries **10** marks]

Q1. In the recent past, Electric Vehicles (EV) were mainly converted from the existing IC engine vehicles by replacing the IC engine and fuel tank with an electric motor drive and battery pack while retaining all the other components. Drawbacks such as its heavy weight, lower flexibility and performance, degradation have caused the use of this type of EV to fade out and later few other configurations were introduced by the manufacturers. Draw neat sketches of four (04) such configurations and write short notes on each of them.

[10.0 Marks]

Q2. Relevant technical details of a Saloon hatch-back car are as follows.

- Vehicle mass 950 kg
- Frontal area 1.9 m^2
- Drag coefficient 0.3
- Fitted with tyres that are specially developed for EVs and have a rolling resistance coefficient of 0.005

Calculate the following, considering only the rolling resistance and the aerodynamic resistance (ignore the gradient resistance).

(i) Calculate the power required at the wheels if the speed is 100 km/h.

[3.0 Marks]

(ii) Calculate the battery power required if the system is 70% efficient.

[3.0 Marks]

(iii) Calculate the mass of the NiMH battery if the Specific Energy is 100 Wh/kg, in case the driving range is 140 km.

[4.0 Marks]

Q3. (i) The major components in a series hybrid drive train include a traction motor, engine/generator, and PPS. The design of the power ratings of these components is the first and most important step in the whole system design. What are the design constraints that must be considered in the design of these parameters?

[4.0 Marks]

(ii) The power rating of the electric motor drive in series HEV is completely determined by vehicle acceleration performance requirements, motor characteristics, and transmission characteristics. At the beginning of the design, the power rating of the motor drive can be estimated, according to the acceleration performance (time used to accelerate the vehicle from zero speed to a given speed). Explain the steps in this calculation and derive the formula for its calculation.

[6.0 Marks]

Q4. The graph Fig. Q4 gives the performance characteristics of electric motors for traction.

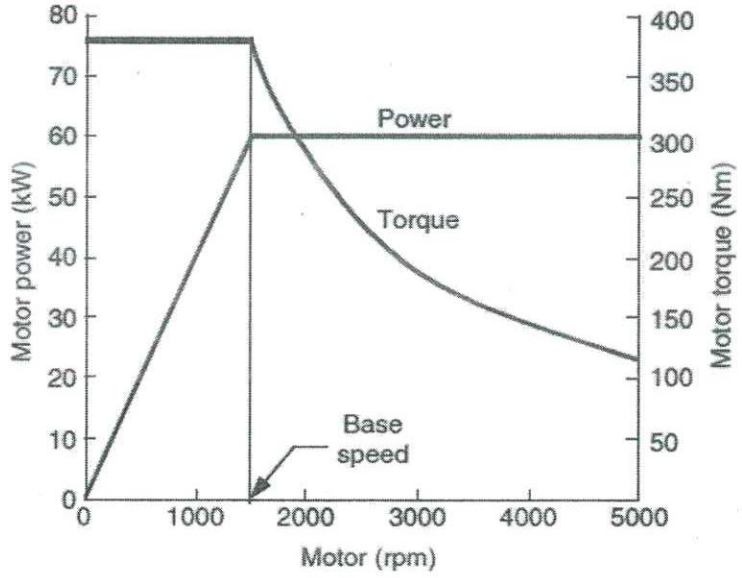

Fig. Q4

Explain followings.

(i) What is the base speed?

[2.0 Marks]

(ii) Explain the behaviour of this graph (Fig. Q4), i.e., varying and constant power and torque regions.

[4.0 Marks]

(iii) A huge investment of time and money is needed to convert totally from conventional drive trains to full hybrids. As a low-cost system, a single battery and a motor can be used. Explain this system, its operation, and its advantages.

[4.0 Marks]

Q5. (i) Humankind is becoming increasingly concerned about the damage it is causing to the environment and electric vehicles are perceived to play a part in redressing the balance. Write short notes on the global effects of conventional fuels and vehicular emissions.

[3.0 Marks]

(ii) Compare the life cycle emissions of conventional, hybrid, and EVs.

[3.0 Marks]

(iii) Flywheels are used in buses, and trolly buses in some cities as energy-storing devices. Draw a layout diagram and explain its working.

[2.0 Marks]

(iv) Compare the different batteries and flywheel performance using specific power vs specific energy graph.

[2.0 Marks]