THE HONG KONG POLYTECHNIC UNIVERSITY

DEPARTMENT OF ELECTRICAL ENGINEERING

Subject Code	:	EE512 / EE512A			
Subject Title	:	Electric Vehicles			
Session	:	Semester 1, 2015/16	**Venue**	:	SPH
Date	:	5th December 2015	**Time**	:	19:00 – 22:00
Time Allowed	:	3 Hours	**Subject Examiner(s)**	:	NC Cheung

This question paper has a total of ____5____ pages (attachments included).

Instructions to Candidates : The paper has 6 questions
Attempt any 5 questions
All questions carry equal marks

Physical Constants : NIL

Other Attachments : NIL

Available from Invigilator : Graph Paper

DO NOT TURN OVER THE PAGE UNTIL YOU ARE TOLD TO DO SO.

Question 1

(a) Fig. Q1a shows the torque speed characteristics of a single gear electric vehicle under FUDS. Describe the driving condition of the electric vehicle in areas A, B, C, and D. (8 marks)

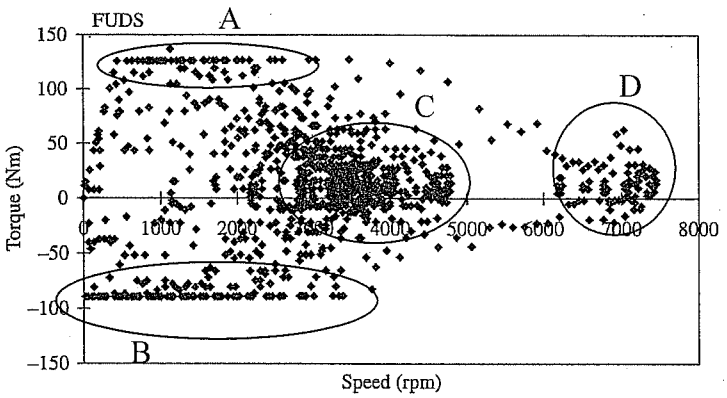

Fig. Q1a

(b) Fig. Q1b shows the classification of electric vehicle and hybrid electric vehicle. Explain the main difference between:

(i) Mild Hybrid Electric Vehicle (Mild HEV) and Full Hybrid Electric Vehicle (Full HEV). (6 marks)

(ii) Plug-in Hybrid Electric Vehicle (PHEV) and Range extended Electric Vehicle (REV). (6 marks)

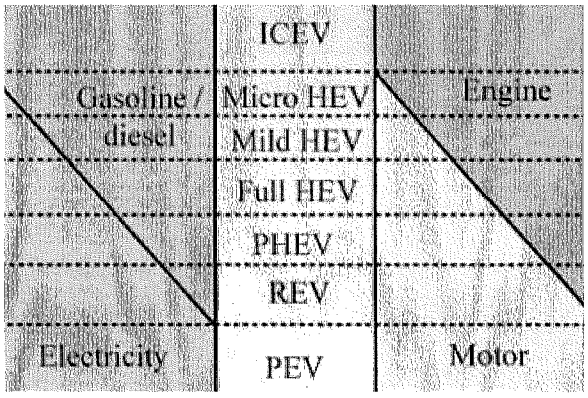

Fig. Q1b

Question 2

(a) Fig. Q2 shows two possible configurations of building an electric vehicle. Compare these two configurations and describe the main advantages and disadvantages between these two configurations. Why is configuration (b) not being used in commercial car nowadays? (10 marks)

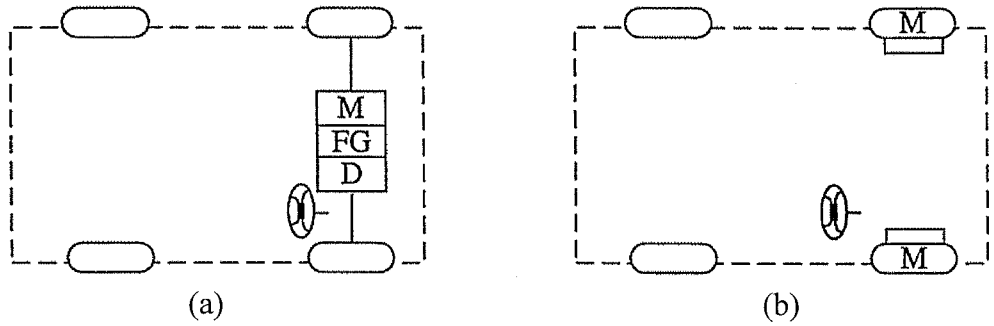

Fig. Q2

(b) By referring to the functional block diagrams and the operating modes, explain the differences between a series hybrid car and an "electric-heavy" series-parallel hybrid car. (10 marks)

Question 3

(a) By referring to the internal construction of a switched reluctance motor, explain why this kind of motor is a suitable candidate for electric vehicles drives. (7 marks)

(b) Explain the "Continuous Current Control" and the "Angular Position Control" driving methods of the switched reluctance motor. Explain why two types of driving modes are necessary for the essential operation of the switched reluctance motor. (8 marks)

(c) Draw the block diagram of a SR motor drive. Explain how the two modes are realized in your drive system. (5 marks)

Question 4

(a) Fig. Q4 shows the Ragone Plots of different types of batteries. Based on this plot, explain why both the fuel cell and the ultra capacitors are not suitable for use as electric vehicle power source alone, but can be very useful when they are combined together. (6 marks)

(b) It is required to design an energy management system which uses both the ultra capacitors and the fuel cell as the energy sources for an electric vehicle. Describe how the two energy sources would compliment each other when the electric vehicle is under:

(i) Hard braking
(ii) Fast acceleration from rest
(iii) Constant high speed highway driving (7 marks)

(c) Draw the functional block diagram of a fuel cell based electric vehicle, and explain why the structure is more complicated than an electric vehicle powered by Lithium Ion batteries. (7 marks)

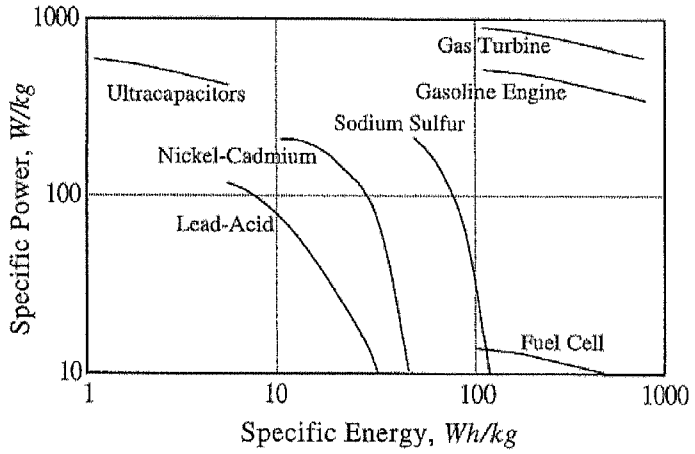

Fig. Q4

Question 5

(a) Explain what is the battery swapping arrangement? Comment on the changes that need to take place, before battery swapping practice for private electric vehicles can be implemented in Hong Kong. (8 marks)

(b) If the motor bus company wishes to modify route A21 service (double-decker bus service between the airport and Hunghom railway terminus) into a pure electric vehicle bus service, what are your suggestions on:

(i) the battery technology used for the bus? (4 marks)
(ii) the charging arrangement (i.e. number of charges per day) of each bus? (4 marks)
(iii) the additional infrastructure requirement? (4 marks)

Your suggestion must include sensible and valid reasoning.

For your information, an ICE double-decker bus weights around 15 tones. In comparison, a Tesler car power pack alone weights 0.4 ton (equivalent to the weight of 6 passengers), and costs around HK$200,000. The average double-decker bus needs at least 20 times the energy of a Tesler car battery pack for a full day operation.

Question 6

(a) In some fast charging stations, the battery of an electric vehicle can be charged up to 80% within 30 minutes. Draw the simplified functional block diagram of such a charging station, and explain how it can be communicated with the battery management system inside the electric vehicle. Your diagram should include the essential communication signals between the car and the charger. (8 marks)

(b) Fig. Q6 shows the distribution of regenerative braking and hydraulic (friction) braking of an electric vehicle at different speeds.

(i) Explain why hydraulic braking ratio is always higher than regenerative braking, even under the most favourable condition. (4 marks)

(ii) Explain why the performance of regenerative braking gets worse at very low speed and at very high speed. (4 marks)

(iii) Explain why there is a peak limit on the amount of regenerative braking. (4 marks)

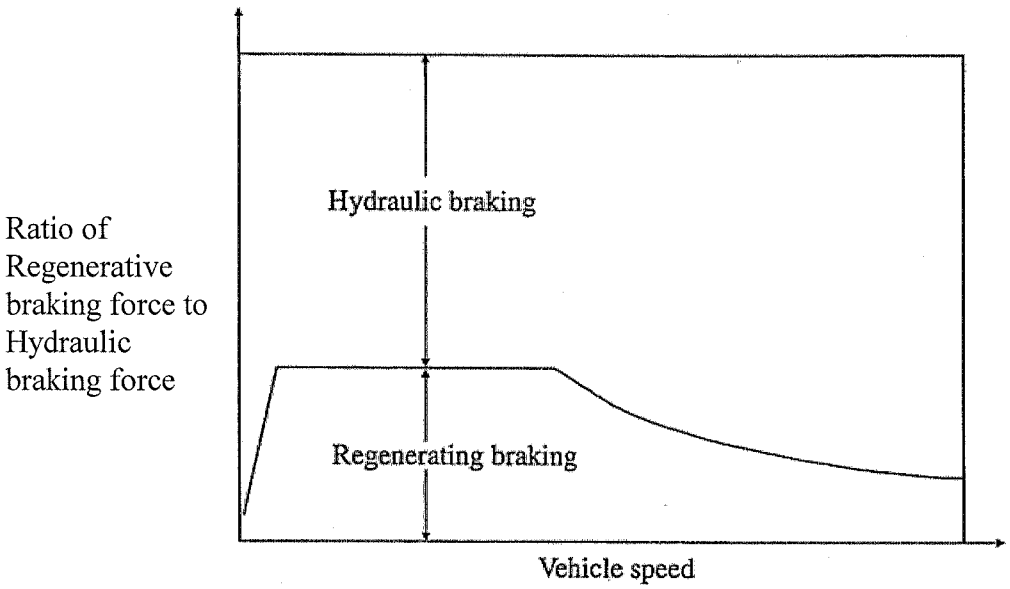

Fig Q6

----- End of Paper -----