DEPARTMENT OF ELECTRICAL ENGINEERING

SOLUTION & MARKING SCHEME

(Semester 1, 2022/23)

SUBJECT (Code & Title)	EE512 ELECTRIC VEHICLES

SUBJECT EXAMINER	Prof. Eric Cheng
SUBJECT MODERATOR	Dr W.C. Lo

<table>
<tr><th>QUESTION NO.</th><th>SOLUTION</th><th>MARKS</th></tr>
<tr><td>Q1</td><td>

Question 1 (25 Marks, 2.5 Marks each)

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<tr><td>Question</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td>Answer</td><td>b</td><td>a</td><td>b</td><td>a</td><td>b</td><td>b</td><td>b</td><td>b</td><td>e</td><td>e</td></tr>
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</td><td>25</td></tr>
<tr><td>Q2(a)</td><td>

The power for each type is number * Energy/1 (h) *50%*0.2

<table>
<tr><th>Type</th><th>Number</th><th>Energy Storage (kWh)</th><th>Power (kW)</th><th>0.5C</th></tr>
<tr><td>Motor cycles</td><td>90000</td><td>10</td><td></td><td></td></tr>
<tr><td>Private Cars</td><td>640000</td><td>50</td><td>16000000</td><td>8000000</td></tr>
<tr><td>Taxis</td><td>18000</td><td>60</td><td></td><td></td></tr>
<tr><td>Franchised Buses</td><td>6500</td><td>300</td><td></td><td></td></tr>
<tr><td>Non-Francised Public Buses</td><td>7000</td><td>300</td><td></td><td></td></tr>
<tr><td>Private Buses</td><td>700</td><td>300</td><td></td><td></td></tr>
<tr><td>Public Light Buses</td><td>4300</td><td>90</td><td>193500</td><td>96750</td></tr>
<tr><td>Private Light Buses</td><td>3500</td><td>90</td><td>157500</td><td>78750</td></tr>
<tr><td>Goods Vehicles</td><td>120000</td><td>200</td><td></td><td></td></tr>
<tr><td>Special Purpose Vehicles</td><td>2000</td><td>200</td><td></td><td></td></tr>
<tr><td>Government Vehicles</td><td>6500</td><td>100</td><td></td><td></td></tr>
<tr><td>Total</td><td>898500</td><td></td><td>16351000</td><td>8175500</td></tr>
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i.e. the power needed is 8175500 kW = **8.1755 GW**

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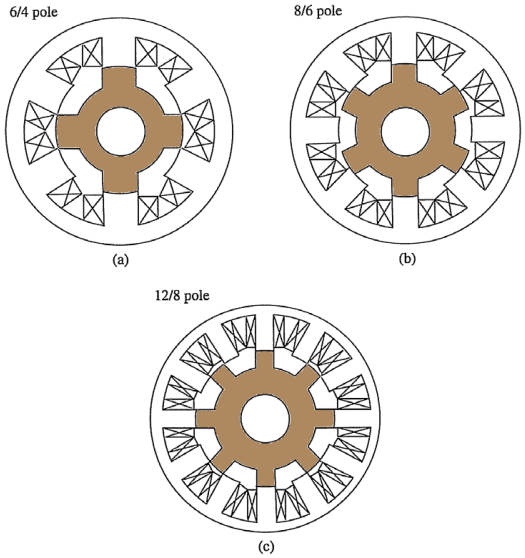
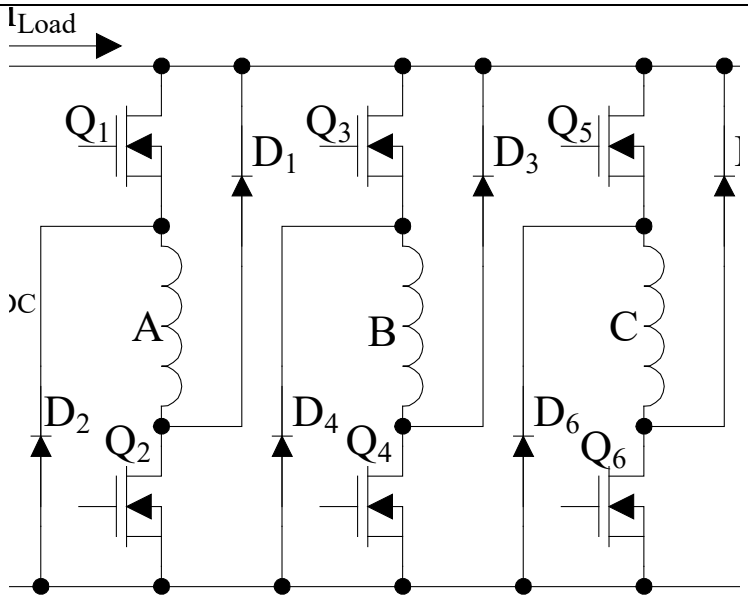
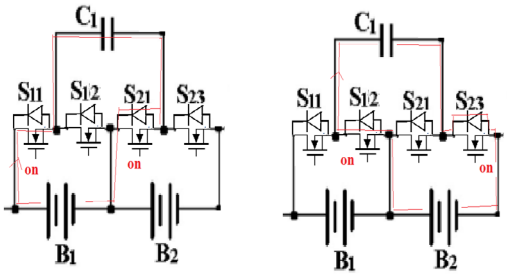
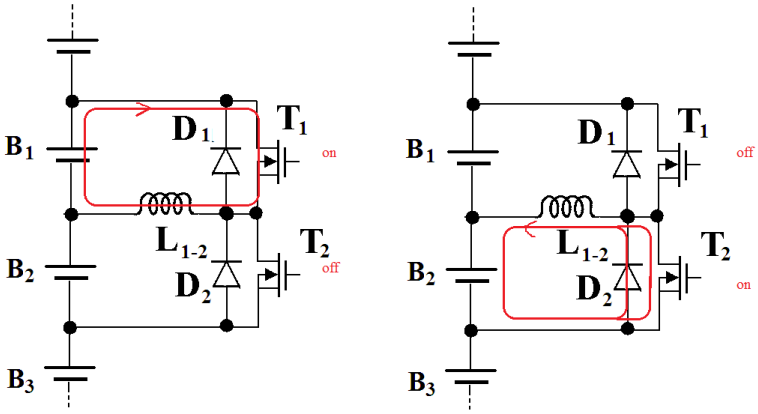
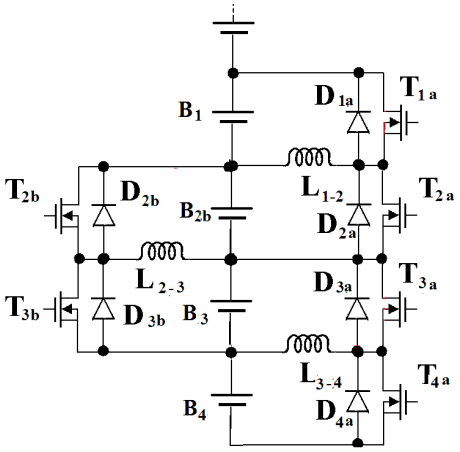
QUESTION NO.	SOLUTION	MARKS
Q2(b)	For example, a typical city like HK is 12GW. This power level is very large as compared to a city's power generation. We shall use **opportunity charging** **load management** **use fuel cell** One of the scheme is to even out the power level by using load demand management. The charging is even out by averageing over 24 hours, the actual power demand is: lower The tycial method is: **The charging can be made during off-peak period or at night** so that the overall power demand can be levelled and the utilization of the power facilities can be evened out. **For day time parking in office building –** Smart charging systems select the non-peak power period for charging. **For night time parking in home garage / overnight parking -** Smart charging systems select the non-peak power period for charging, even out the whole 24-hr power demand from the grid.	4
Q2(c)	Switched-reluctance motor Lower cost No rotor widning No permanent magnet Anyone below: 	3

QUESTION NO.	SOLUTION	MARKS
		2 2
Q3(a)	The circuit operation of switched-capacitor converter is (the reverse curent can pass through diode of Mosfet when it is on): 	4 marks
Q3(b)	The circuit operation of buck-boost converter is: 	4 marks

QUESTION NO.	SOLUTION	MARKS
Q3(c)		4 marks
Q3(d)	• The increasing component count in active balancing • Passive balancing can provide max voltage protection • The mature method in passive balancing • Reliable	4 marks
Q3(e)	The internal short circuit of the cell is **difficult** to be protection by BMS. Therefore the system replies on the **detection of the changes** in cell characteristics such as: Impedance, SoH, and temperature of operation in order to have **early warning**.	4 marks
Q4(a)	1. HK is small. Mileage is low. Battery requirement is low. 2. HK is mostly city environment driving, with frequent starts and stops. 3. HK is hot in summer. ICE engine cars cannot leave air conditioning on, but EV can. (no idling i.e. no idling issue) 4. Electric power distribution is highly developed, and its capacity can always expand. 5. People live close to major roads. ICE car is a major noise pollution in HK.	5 marks
Q4(b)	1. Hydrogen operates in high pressure 700 or 350 bars that impose issues in city application 2. Hydrogen has safety issues in tunnels and bridges due to fire regulation 3. The supply chain of hydrogen needs the installation of gas pipes and shipment that has not yet been developed 4. The cost of hydrogen is still expensive. Much higher than diesel 5. The availability of hydrogen vehicles is low. Vert few choices	5 marks
Q4(c)	The gasoline station in Hong Kong are mostly in a city Hydrogen station is hazardous and not suitable to be installed in a city The operation is different. Gasoline is liquid. H2 is gas The fire regulating considers H2 is highly flammable. Not suitable for station in the city Hydrogen station should be newly built as they use different technology.	5 marks
Q4(d)	Any 5 points: • High specific energy and energy density • High specific power and power density • High C-rate (fast charging and discharge) • High deep discharging capability • Long lifetime • Low self-discharging	5 marks

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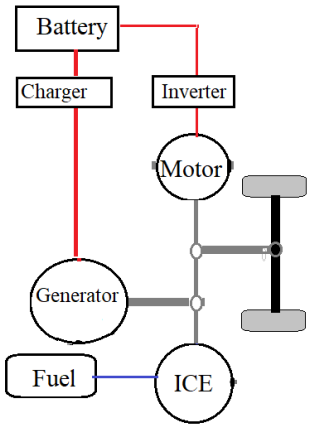
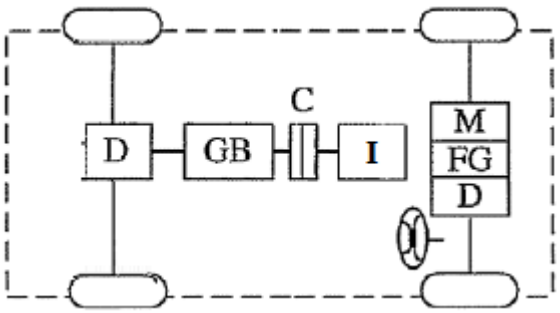
	• Low maintenance requirement • High efficiency (discharge/charging) • Material recycling • Low in toxicity • Overall environmentally friendly • Good in supply train , or no monopoly	
Q5 (a)	Any 5: Advantages of Differential: 1) Differential drive is mechanically complicated, with lower efficiency. 2) Differential drive is safer than in-wheel drive, in case when one motor malfunction. Advantage of in-wheel: 3) In-wheel drive has low component count, thus more reliable. 4) In-wheel drive has high inertia and heavy wheel mass. Disadvantage of in-wheel: 5) Suspension is not good. 6) In-wheel motor electronic drive is much more complicated than differential drive.	5 marks
Q5 (b)	 **Red: Electrical connection** **Grey: Mechanical Connection** **Blue: Fuel Connection**	5 marks
Q5(c) (i)		3 marks
Q5 (c) (ii)	It is a series-parallel hybrid ICE is connected to Differential to the rear wheel that is parallel to the front wheel that is connected with the motor-driven differential, through the parallel connection using the road surface The ICE is also driving the motor (now generator) as a series connection.	3 marks

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	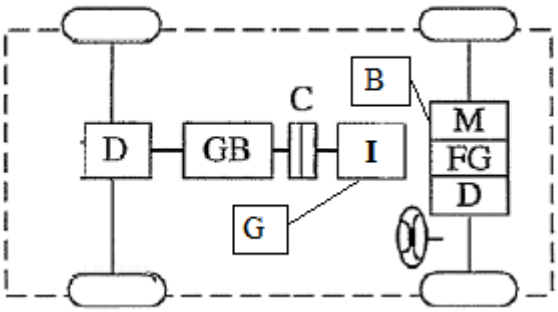 B: Battery G: Gasoline	2 marks
Q5(c) (iii)	Any two: Advantages: Reduce the series connection using electrical or mechanical transmission Provide rear and front toque control Disadvantage: Weak in the left/right torque/speed control Power generation or charging the battery's capability is limited	2 marks