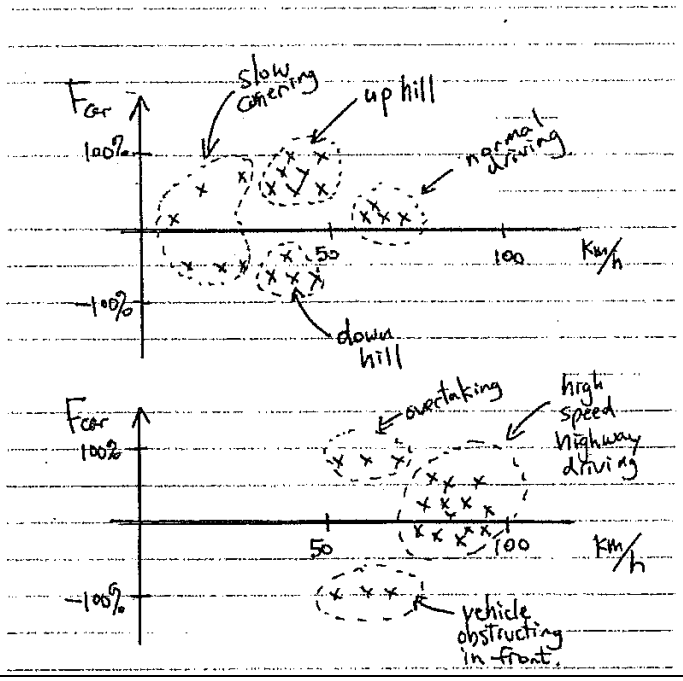
DEPARTMENT OF ELECTRICAL ENGINEERING

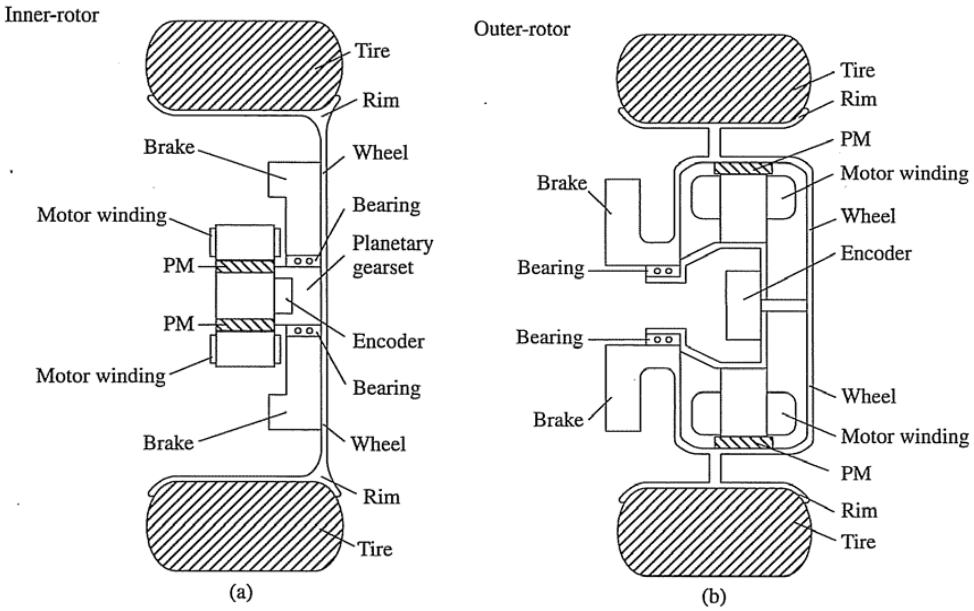
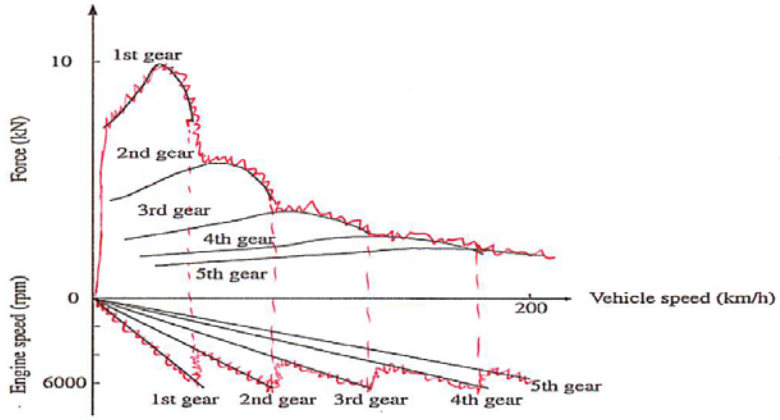
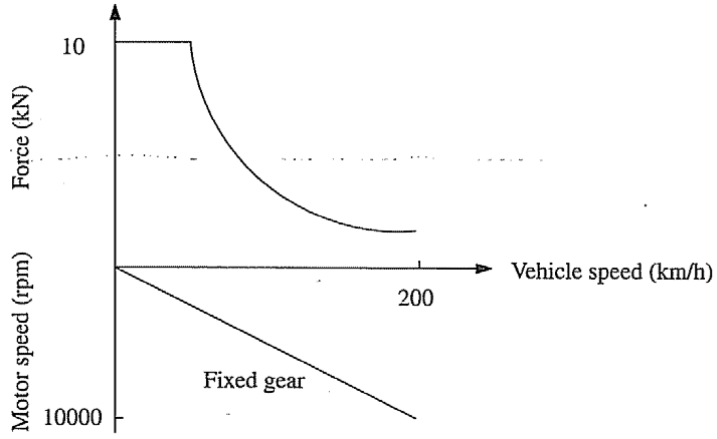
SOLUTION & MARKING SCHEME

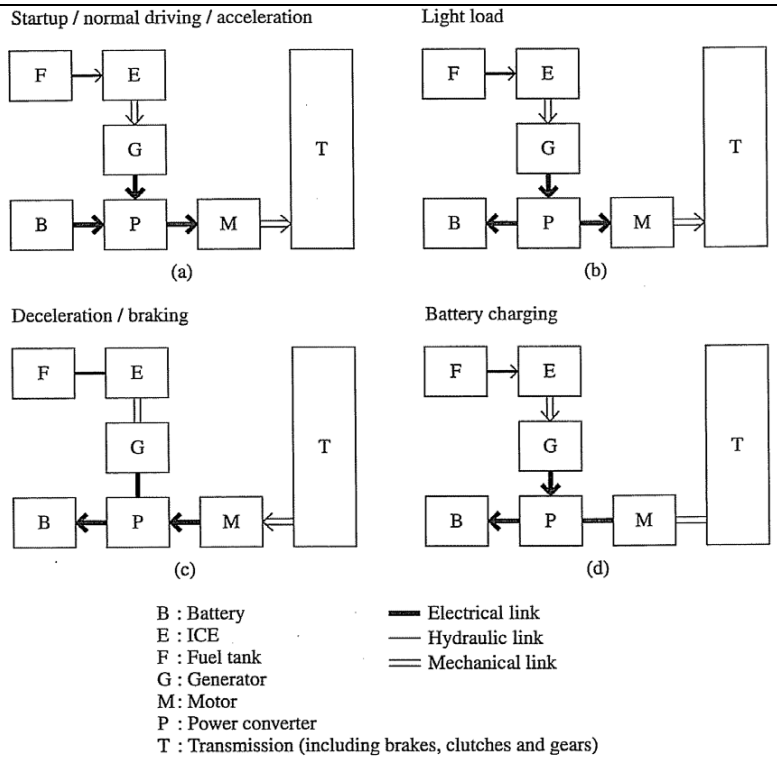
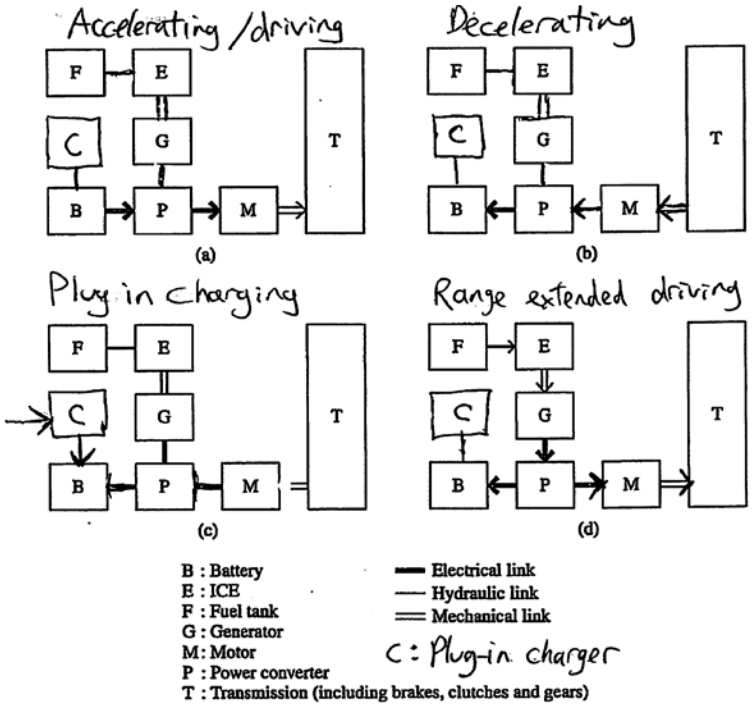
(Semester 1, 2018/19)

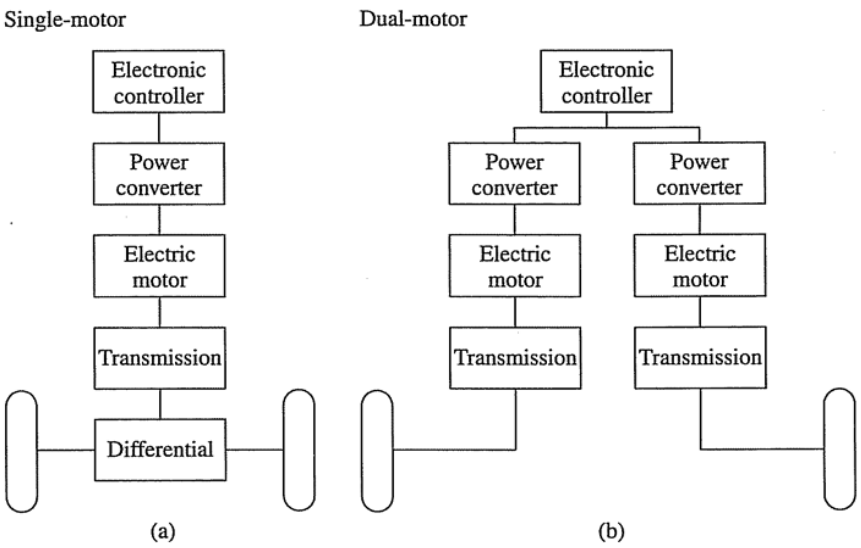
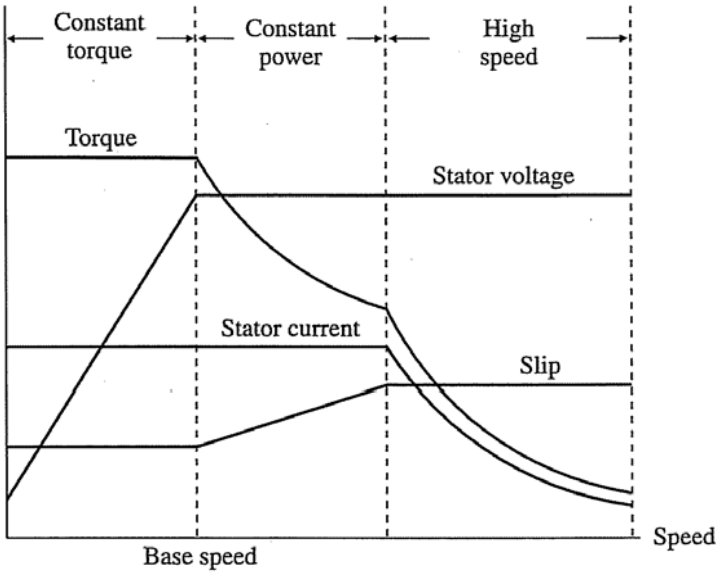
SUBJECT (Code & Title)	EE512/EE512A Electric Vehicles

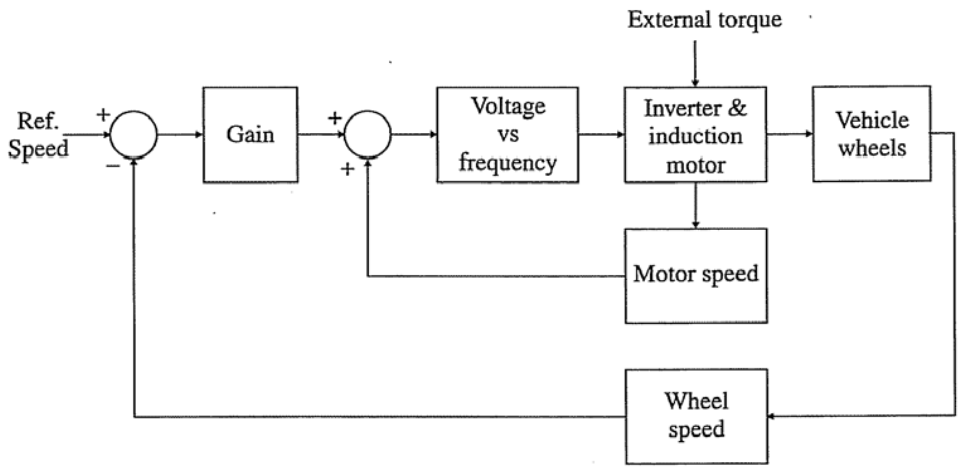
SUBJECT EXAMINER	NC Cheung
SUBJECT MODERATOR	E Cheng

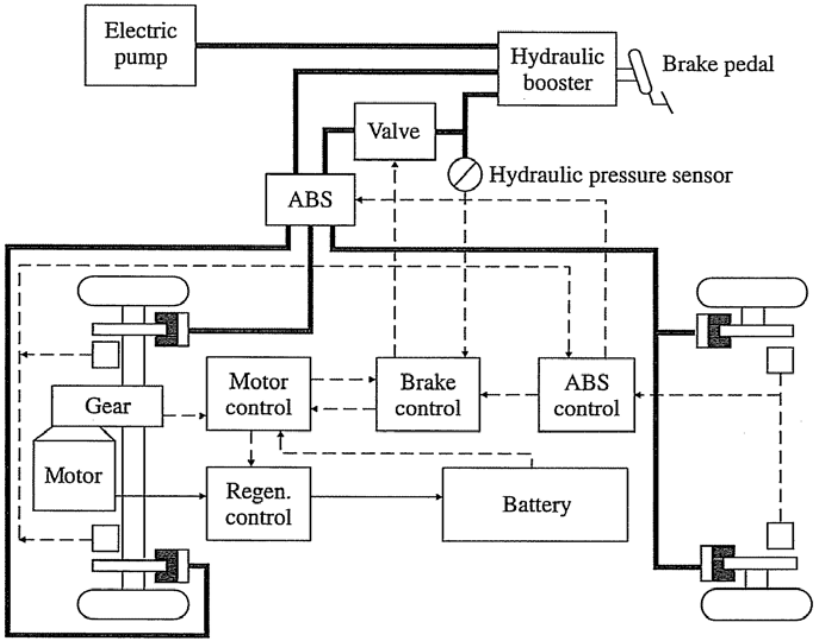
QUESTION NO.	SOLUTION	MARKS
Q1 (a)		7
(b)		7
(c)	Motorcycle – most easy – light weight – needs small battery capacity – usually short distance travel 4 seater – middle – medium weight – needs more battery capacity – no need to go long di Truck – most difficult – battery weight is significant – needs to go long distance – long driving hours – difficult to achieve high goods weight to truck weight ratio.	6
Q2 (a) (i)	Fuel cell battery has low specific power, but has high specific energy but cannot accept regenerative energy, it is preferable to combine it with a battery with high specific power and high energy receptivity.	3
(a) (ii)	Rather than storing it as a compressed gas, a liquid or a metal hydride, hydrogen can be on-board generated from ambient-temperature liquid fuels such as methanol or even petrol. As shown in Fig. 3.4(d), a mini reformer is installed in the EV to produce on line the necessary hydrogen gas for the fuel cell.	3

QUESTION NO.	SOLUTION	MARKS
Q2 (b)	 smaller motor size need planetary gear set lower inertia lighter large motor size direct drive, no gear mechanics higher inertia more heavy	6
Q2 (c)	 When ICE vehicle accelerates from rest to max speed… It suffers from low start up torque, torque delay, non-smooth speed increase (due to gear change)  But EV has instant max torque, no delay, smooth speed increase, and no need to change gear	8

QUESTION NO.	SOLUTION	MARKS
Q3 (a)	4 key goals 1. Max fuel economy 2. Minimum emissions 3. Minimum system cost 4. Good driving performance	4
Q3 (b)		8
Q3 (c)	A plug-in charging unit block is added, denoted by "c" 	8

QUESTION NO.	SOLUTION	MARKS
Q4 (a)	2 different configurations:  **Fig. 5.2.** Single- and multiple-motor configurations. Differential gear is present — No complicated differential gear Mechanically complicated — Simple mechanics Malfunction will not have car spinning — malfunction, car may spin out of control Single motor and drive only — motor and drive needs to be duplicated Controller relatively simple — complicated controller	6
Q4 (b)	 Constant torque mode – during start up. Max current, increasing voltage, with min slip Constant power mode – mid-speed range. Max V and I, and increasing slip. Torque will decrease as speed in increased. High speed – as speed further picks up, overall power needs to decrease. Max slip, max V, with exponential decrease of torque and current	9

QUESTION NO.	SOLUTION	MARKS
Q4 (c)	 Add some explanation…..	5
Q5 (a)	(i) Fuel Cell – use fuel, with long driving range. No power regeneration (ii) Metal Air Battery – Mechanical recharge. No power regeneration (iii) Lithium Battery – Very high specific energy. Long charging time (iv) Lead Acid Battery – Cheap. Low spec in all aspects (v) Super Capacitor – V high specific power. V low specific energy	10
(b)	ANY 5: Prevention of battery overcharge Avoidance of battery over-discharge Control of battery temperature Balancing of module voltages and temperatures Prediction of SOC and residual driving range Battery diagnosis	5
(c)	1. Coupling efficiency is low 2. Alignment problem 3. Difficult for high power transfer 4. Pick up coil size too big and heavy 5. The two coils need to be very close to each other	5

QUESTION NO.	SOLUTION	MARKS
Q6 (a)	 **Fig. 7.37.** Configuration of a regenerative-hydraulic braking system. Add some explanation	10
Q6 (b)	Non-technical challenges for battery swapping: 1. All parties need to agree on a standard size and connection method 2. Battery technology progress is still v fast and competitive, to agree on point 1. is difficult 3. Who owns the battery? Who will bear the initial purchase cost? 4. The battery storage and charging station takes up a lot of space. 5. Battery transfer between charging station is a logistics nightmare	5
Q6 (c)	1. The total cost of ownership of EV is now cheaper than an ICEV 2. EV is more intelligent. Can easily integrated with auto-parking, auto driving, etc. 3. The environmental cost of EV is getting less, as the world embraces renewable energy 4. Overall performance of EV is better than ICEV 5. Government regulations is more favourable towards EV than ICEV.	5