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试卷装订线

装订线内不要答题，不要填写考生信息

试卷装订线

Test Paper of Wuhan University of Technology (A)

2018-2019 Academic Year, 1st Semester, Course: Structures and Theory of New Energy Vehicle, Closed-book Exam

Time: 120 mins, 32 class hours, 2.5 credits, Total Points: 100, Percent in final evaluation result: 60%, Date: December 2018

No.	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
Full score	10	20	15	20	15	20					100
Score	2	2	10	10	10	15					59

Score	2
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I. Fill in the blanks (2 points*5=10 points)

- The conventional methods of charging accumulators mainly include: constant-current charging method, stepped current charging method, constant-voltage charging method, and stepped voltage charging method.
- The main methods of recovering braking energy of electric vehicles include: hydraulic energy storage and electrochemical energy storage.
- The drive motors commonly used in new energy vehicles include: permanent magnet synchronous motors, permanent magnet brushless motors and switched reluctance motors.
- Four directions of vehicles as defined in "Made in China 2025" include: full electric vehicle, fuel-efficient vehicles, fuel-cell vehicles and intelligent and connected vehicles.
- The key technologies of electric vehicles include: battery and management technology, rapidly charging technology, vehicle control technology, and vehicle lightweight technology.

得分
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II. Single-choice questions (2 points * 10=20 points)

- What is the wrong description about SOC of batteries? (D)
 - Prevent battery from overcharge and overdischarge
 - Serve as a low-battery current limiting threshold
 - Serve as a threshold of vehicle control strategy
 - Serve as an important basis for measuring battery quality
- What's the fuel used by the positive pole of hydrogen cell? (A)
 - O₂
 - H₂
 - Methyl alcohol
 - Ni(OH)₂
- Which of the following options can be expressed as the speed characteristic of a shunt (separately) excited DC motor? (A)
 - $n = \frac{U - R_a I_a}{C_e \Phi}$
 - $n = \frac{U - 2\Delta U - 2I_a R_a}{C_e \Phi}$
 - $s = \frac{n_1 - n}{n_1}$
 - $n = n_0 + \Delta n$
- In order to obtain a high-voltage power battery, the single battery can be: (A)
 - Connected in series
 - Connected in parallel
 - Connected in series or parallel
 - None of the above
- Which of the following instruments in traditional vehicles is not installed in electric vehicles? (C)
 - Voltmeter
 - Power meter
 - Engine tachometer
 - Battery capacity indicator

11. What is the fuel cell most widely applied in fuel-cell electric vehicles? (~~D~~)

- A. AFC B. SOFC C. PAFC D. PEMFC

12. Which of the following components is excluded from the power assembly of a series hybrid electric vehicle? (~~C~~)

- A. Engine B. Generator C. Drive motor D. Control motor

13. What is the main evaluation index of vehicles' dynamic performance? (A)

- A. Starting acceleration performance and climbing performance
B. Battery performance and motor performance
C. Climbing performance and motor performance
D. Motor performance and starting acceleration performance

14. What is the function of accumulators in hybrid electric vehicles? (B)

- A. Provide auxiliary power supply for BMS
B. Transmit kinetic energy of automobiles to the accumulator through the traction motor
C. To be charged and discharged in a nonperiodic manner
D. To increase power

15. What's the wrong description about the reaction mechanism of fuel cells? (D)

- A. The chemical energy in the fuel can be converted into electric energy directly without burning.
B. The chemical energy can be converted into electric energy through electrochemical reaction.
C. In fact, it's the inverse process of water electrolysis.
D. Water will be generated and electric energy will be released through physical reaction between hydrogen and oxygen.

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III. Short-answer questions (5 points * 3 = 15 points)

16. What are the main requirements of electric vehicles for power batteries? (5 points)

- solution:
1. long life.
 2. low cost of batteries.
 3. high allow discharge depth.
 4. ~~give~~ high speed of charging.
 5. high volumen.

17. What are characteristics of permanent magnet synchronous motors? (5 points)

1. have a high ratio of energy changing.
2. high cost and complex.
3. safe and have a high ~~work~~ efficiency.

18. What are the advantages of fuel-cell electric vehicles? (5 points)

- solution:
1. ~~less~~ ^{less} pollution than traditional vehicles.
 2. higher ratio of energy changing than traditional vehicles.
 3. It's engine is ~~quite~~ ^{quite} than traditional vehicles, has a low dB motor noises.
 4. It's save more ~~more~~ energy.
 5. It's more stable and smarter.

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IV. Fill in the blanks according to the figure (10 points*2=20 points)

19. Please fill in the following table in combination with characteristics of power battery for electric vehicles. (2 point*5=10 points)

Table 4.1 Technical Performance of Three Kinds of Power Batteries

Technical performance	Lead acid battery	Nickel metal hydride battery	Lithium ion battery
Operating voltage (V)	2	1.2	3.6
Specific energy (Wh/kg)	40	65	105-140
Specific power (W/kg)	150-200	160-230	250-400
Charge and discharge life (times)	500-700	600-1200	800-1200
Self-discharge rate (%) (monthly)	3	30-35	6-9
With/without memory effect	with	With	without
With/ without pollution	With	without	without

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20. Please fill in the blanks in the figure below according to the characteristics of the series-parallel hybrid electric vehicles (PSHEV). (2 points*5=10 points)

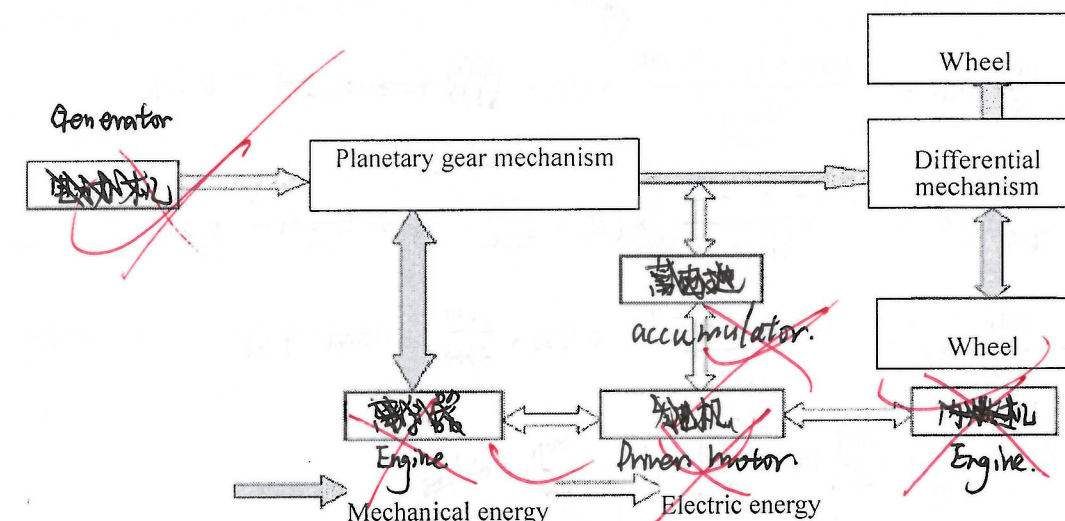


Figure 4.1 Diagram of Power Flow of PSHEV

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V. Calculation and analysis questions (15 points*1=15 points)

21. The relevant data of a full electric vehicle are as follows:

The gross vehicle mass (m): 1,150 kg; coefficient of air resistance (C_D): 0.3; windward area (A): 2.58 m²; rolling resistance coefficient (f): 0.015; transmission efficiency (η_T): 92%; tyre radius (r): 0.305 m; maximum speed ($u_{a\max}$): 120 km/h; overall efficiency of motor and motor controller ($\eta_m\eta_{mc}$): 90%; total voltage of power battery pack (V_b): 342 V; allowed discharge depth (DOD): 90%. It is required that when the speed (u_{ai}) is 10 km/h, the maximum gradability (i) shall be 30%; when the speed (u_{as}) is 40 km/h, the mileage (S) for which the vehicle can travel at a constant speed shall be 150 km.

(1) Please work out the motor power P_{mi} (kW) required to reach the specified maximum gradability. (5 points)

Solution: $P_{mi} = \left(\frac{mgf}{3600} u_{ai} + \frac{C_D A}{76140} u_{ai}^3 + \frac{mg_i}{3600} u_{ai} \right) / \eta_T$ $u_{ai} = 10 \text{ km/h} = \frac{10 \times 1000}{3600} \text{ m/s} = 2.78 \text{ m/s}$

1. $\frac{mgf}{3600} u_{ai} = \frac{1150 \times 10 \times 0.015}{3600} \times (10 \times \frac{1000}{3600}) = 0.48$

2. $\frac{C_D A}{76140} u_{ai}^3 = \frac{0.3 \times 2.58}{76140} \times (10 \times \frac{1000}{3600})^3 = 0.01$

3. $\frac{mg_i}{3600} u_{ai} = \frac{1150 \times 10 \times 0.3}{3600} \times (10 \times \frac{1000}{3600}) = 9.58$

$P_{mi} = \frac{1}{\eta_T} \left(\frac{mgf}{3600} u_{ai} + \frac{C_D A}{76140} u_{ai}^3 + \frac{mg_i}{3600} u_{ai} \right)$

$= 10.99 \text{ kW}$

(2) Please work out the motor power P_{ms} (kW) required to make the vehicle drive at the constant speed (u_{as}) of 40 km/h. (5 points)

Solution:

$P_{ms} = \left(\frac{mgf}{3600} u_{as} + \frac{C_D A}{76140} u_{as}^3 \right) / \eta_T$

$= \left(\frac{1150 \times 10 \times 0.015}{3600} \times 40 + \frac{0.3 \times 2.58}{76140} \times 40^3 \right) / \eta_T$

$= (1.917 + 0.651) / \eta_T$

$= 2.79 \text{ kW}$

(3) Please work out the battery capacity C_b (Ah) required to enable the vehicle to travel for the specified mileage under the allowed discharge depth. (5 points)

Solution:

$C_b = \frac{1000 [P_{ms} / (\eta_m \eta_{mc})] (S / u_{as})}{V_b \cdot DOD}$

$= \frac{1000 \times [2.79 / 0.9] (150 / 40)}{342 \times 0.9}$

$= 37.77 \text{ Ah}$

The reference formulas are as follows:

Motor power required to reach the specified maximum gradability

$P_{mi} = \left(\frac{mgf}{3600} u_{ai} + \frac{C_D A}{76140} u_{ai}^3 + \frac{mg_i}{3600} u_{ai} \right) / \eta_T$

Motor power required to make the vehicle drive at the constant speed (u_{as}) of 40 km/h

$P_{ms} = \left(\frac{mgf}{3600} u_{as} + \frac{C_D A}{76140} u_{as}^3 \right) / \eta_T$

Battery capacity required to enable the vehicle to travel for specified mileage

$C_b = \frac{1000 [P_{ms} / (\eta_m \eta_{mc})] (S / u_{as})}{V_b \cdot DOD}$

得分
Score

六、综合论述题（每题 20 分，共 20 分）

VI. Comprehensive essay-type questions (20 points*1=20 points)

22. Combined with the course content of "Structure and Principle of New Energy Vehicle" and according to the development trend of key technologies of new energy vehicles at present, please discuss the following topic:

Topic: Roadmap of the development of new energy vehicles.

Requirements: 300-350 words.

Solution:

With the development of technology of new energy vehicle, a significant countries and big companies realise that it's vital to grow new energy vehicle and own their key skill.

In the last century, electric vehicle broke in the European but disappear in the market soon because traditional oil vehicle have more advantages. But now many energies are in short and AI ~~teache~~ technology have a great progress, which make new energy vehicle become a popular topic. Like rapidly changing ~~teach~~ technology, battery and management technology, vehicle control technology and vehicle lightweight technology, have become the top four hot technology in these years. In the same time, battery problem is also a huge problem. Lead acid battery, Nickel metal hydride battery and Lithium ion battery are hard to satisfy the requirement of electric vehicle.

In the further, we can image the picture the new energy vehicle

take place of traditional vehicle, we can make full use of limit energy and recourse by a environment-friendly way.

To get the purpose, we can work from four directions: full electric vehicle, fuel-efficient vehicles, fuel-cell vehicles, and intelligent and connected vehicles.

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