

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	0	14	10	14	8	15					61

Score	0
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I. Fill in the blanks (2 points*5=10 points)

1. The conventional methods of charging accumulators mainly include: constant-current charging

method, stepped current charging method, constant-voltage charging method, and ~~fast-charging~~ *etc. method*

2. The main methods of recovering braking energy of electric vehicles include: ~~mechanical~~ *energy storage*
hydraulic energy storage and electrochemical energy storage.

3. The drive motors commonly used in new energy vehicles include: ~~direct~~ *current asynchronous*, AC asynchronous
motors, permanent magnet brushless motors and switched reluctance motors.

4. Four directions of vehicles as defined in "Made in China 2025" include: ~~new-energy~~ *fuel-efficient*
vehicles, fuel-cell vehicles and intelligent and connected vehicles.

5. The key technologies of electric vehicles include: battery and management technology, ~~fuel-change~~ *technology*
vehicle control technology, and vehicle lightweight technology.

得分
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14

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

6. What is the wrong description about SOC of batteries? (B)

- A. Prevent battery from overcharge and overdischarge
- B. Serve as a low-battery current limiting threshold
- C. Serve as a threshold of vehicle control strategy
- D. Serve as an important basis for measuring battery quality

7. What's the fuel used by the positive pole of hydrogen cell? (B)

- A. O₂
- B. H₂
- C. Methyl alcohol
- D. Ni(OH)₂

8. Which of the following options can be expressed as the speed characteristic of a shunt (separately) excited DC motor? (A)

A、 $n = \frac{U - R_a I_a}{C_e \Phi}$

B、 $n = \frac{U - 2\Delta U - 2I_a R_a}{C_e \Phi}$

C、 $s = \frac{n_1 - n}{n_1}$

D、 $n = n_0 + \Delta n$

9. In order to obtain a high-voltage power battery, the single battery can be: (C)

- A. Connected in series
- B. Connected in parallel
- C. Connected in series or parallel
- D. None of the above

10. Which of the following instruments in traditional vehicles is not installed in electric vehicles?

(C)

- A. Voltmeter
- B. Power meter
- C. Engine tachometer
- D. 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.

得分	10
Score	

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

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

Answer: The main requirements of electric vehicles for power batteries are safety, construct, low price, high power and specific power, suitable size and efficient.

+3

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

Answer: The characteristics of permanent magnet synchronous motors include the fit between the stator and rotor, right performance of the whole motors. The enough power about the battery.

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

Answer: The advantages of fuel-cell electric vehicles are high specific power and high power density, convenient skill to storage the fuel, affluent fuel types, mature technology.

得分
Score

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

110

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)

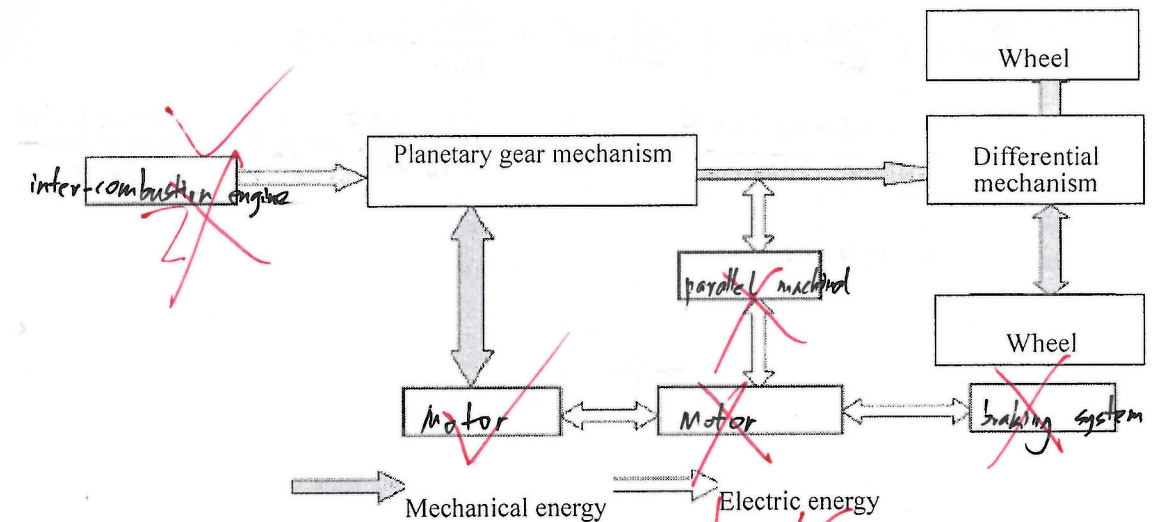


Figure 4.1 Diagram of Power Flow of PSHEV

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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)

Answer: As we can see from the question.

$$P_{mi} = \left(\frac{mgf}{3600} ua_i + \frac{C_D A}{76140} ua_i^3 + \frac{mgi}{3600} \mu a_i \right) / \eta_T$$

$$= \left(\frac{1150 \cdot 9.8 \cdot 0.015}{3600} \cdot 10 \cdot \frac{1}{3.6} + \frac{0.5 \cdot 2.58}{76140} \left(10 \cdot \frac{1}{3.6} \right)^3 + \frac{1150 \cdot 9.8 \cdot 0.5}{3600} \cdot 10 \cdot \frac{1}{3.6} \right) / 0.92$$

$$= 0.4782 \text{ kW}$$

+2

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

Answer: As we can see from the question

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

$$= \left(\frac{1150 \cdot 9.8 \cdot 0.015}{3600} \cdot 10 \cdot \frac{1}{3.6} + \frac{0.5 \cdot 2.58}{76140} \left(10 \cdot \frac{1}{3.6} \right)^3 \right) / 0.92$$

$$= 0.1768 \text{ kW}$$

(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)

Answer: As we can see from the questions.

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

$$= \frac{1000 [0.1768 / 0.9] [150 \times 10^3 / (40 / 3.6)]}{342 \cdot 0.9}$$

$$= 8.567 \times 10^4 \text{ Ah}$$

+3

The reference formulas are as follows:

Motor power required to reach the specified maximum gradability

$$P_{mi} = \left(\frac{mgf}{3600} ua_i + \frac{C_D A}{76140} ua_i^3 + \frac{mgi}{3600} \mu a_i \right) / \eta_T$$

Motor power required to make the vehicle drive at the constant speed (ua_s) of 40 km/h

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

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

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

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.

Answer: With the economy and the development of the trend of the globalization. More and more new technologies and new options have become the theme of the countries all around the world about how to develop the manufacturing. And depend on the environment and the power aspects. The most used machine: vehicles became the important point to revolution. So New Energy Vehicle has become the sured tendency aim in the future. At first, It's the reluctant acquires because the fuel, traditional things, has become dissatisfactory. So we have no choice to explore the new power to develop the vehicle. The other question is the environment problem that the ice in the North point has merged by the sea line and the global warming became severe. And all those question are attached to the fuel power. So the reason about why we should pay attention to it is obvious. And now, with the day by day. China becomes one of the most important place on the new energy vehicle, with the obvious problem. At first, the storage of the new power become a element limit. For example, if you choose the electric power as the main expense, how to charge the car become a new point. because the low efficiency confer to fuel-power car is not cool. And the other problem is the cruelly

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competition with the fuel cars. As the summarized reasons, the biggest disadvantage is the low performs, but the price is as much high as those prevent cars. so the path of the Chinese new-energy-car is still longer and longer. we need emphasize the confidence and the positive attitude about the future. And the motor of the new-energy car can become a varieties of the size and the mass meter. So the use of the new car could become more and more popular.