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# Test Paper of Wuhan University of Technology (A)

2018-2019 Academic Year 2nd Semester, Course: Automobile Electric Appliances and Electronic Control Systems, Closed-book Exam  
Time: 120mins, 48 class hours, 3 credits, Total Points: 100, Percent in final evaluation result: 60%, June 2019

| No.        | I  | II | III | IV | V | VI | VII | VIII | IX | X | Total |
|------------|----|----|-----|----|---|----|-----|------|----|---|-------|
| Full score | 20 | 42 | 38  |    |   |    |     |      |    |   | 100   |
| Score      | 1  | 10 | 30  |    |   |    |     |      |    |   | 41    |

Score 1

I. Fill in the blanks (2 points \* 10 = 20 points)

- Modern automobiles generally adopt three-phase synchronous alternator (三相同步交流发电机), transfer AC into DC via 二极管 circuit, and maintain the generator voltage steady through 调节器.
- The starter consists of 起动机, transmission mechanism (传动机构) and 电源.
- The engine starting system is mainly composed of power supply, starter motor and control circuit of the starter (起动机).
- The automotive electric system is characterized by low voltage, DC, ECU and Actuator.
- There are mainly three types of engine speed sensors: magnetic inductive, 霍尔式 and 光电式 engine speed sensors.
- The spark advance mechanisms of traditional contact-controlled ignition system (触点式点火系统) include 机械式 and 电子式.
- Automatic transmission (AT) shifts gear automatically according to 液力传动 and 机械辅助变速.
- EPS system is classified into 转向传感器, pinion type electric power steering and 电动机 according to the position of the power mechanism.
- ESP system integrates the basic functions of electronic brake force distribution, ABS and 执行装置 EPB.
- Automotive electronic cruise control system uses 车速传感器 as the feedback signal and keep the automobile speed steady by adjusting 节气门.

Score 10

II. Short-answer questions (42 points for 6 questions)

- What are the basic requirements of the gasoline engine ignition system? (6 points)  
足够的二次电压  
足够的点火能量  
适当的点火时间

+6

- How does the photoelectric steering wheel angle sensor (光电式转向盘转角传感器) measure the steering angle and rotation direction? (6 points)  
通过转盘上的孔 改变透光次数, 从而确定转角大小
- The electric fuel injection system of the automobile controls the fuel-injection quantity by controlling the fuel-injection time. How does it ensure the accuracy of fuel-injection quantity? (8 points)  
各种传感器: 如曲轴位置传感器、空气流量、发动机冷却温度、节气门位置传感器等将相关数据传给ECU, ECU再将数据经过计算后得到加油时间, 再将数据传给油泵执行。

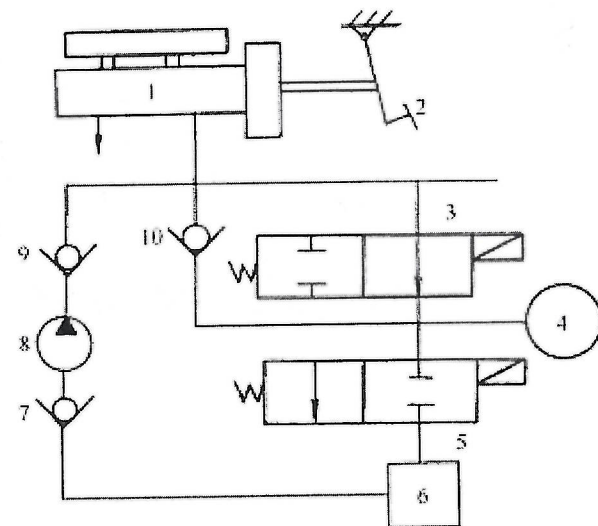
4. What are the influences of battery voltage on engine electronic control systems? (8 points)

在提供大电流给起动机时,需保证电压平稳,才能保证启动顺畅

5. What are the components of hydraulic-drive automatic transmission (AT) and the functions of these components? (6 points)

- 1) 液力传动装置: 液力变矩器通过液力传递力, 将飞轮输出功率传递给行星齿轮机构
- 2) 辅助变速装置: 进一步增矩减速, 通过传动比变化, 提高汽车适应性
- 3) 自动适应系统: 电子控制系统与液压控制系统

6. The figure below is the schematic diagram of circulating-flow brake pressure regulator (循环流动式制动压力调节器). What are the elements 3, 5 and 8 respectively stand for? What is the working state of pressure regulator in the figure? (8 points)



Score 30

### III. Calculation (38 points)

1. (10 points) The minimum speed of an engine is 100 rpm and the transmission ratio of the retarding mechanism (减速机构) of its starting system is 10: 1,

- (1) If a torque of 360Nm is required to overcome static friction, in order to start the engine, what is the minimum stall torque (the torque when the motor has a speed of zero (stalls)) required to start the motor (3 points)

$$T_{min} = \frac{360 N \cdot m}{10} = 36 N \cdot m$$

+3

- (2) If the engine has to overcome 100Nm friction torque to keep it running at the minimum speed, please calculate the driving torque when starting the motor under such status. (3 points)

$$P = \frac{1}{9550} \frac{100 \cdot 1000}{n_{sTs}} = \frac{100 \cdot 1000}{9550} = 1.05 kW$$

+0

- (3) If the efficiency of the starter is 60%, what is the input power required to start the motor, in order to keep the engine running at its lowest speed? (4 points)

$$C = \frac{1}{0.6} \cdot \frac{100 \cdot 1000}{9550} = 11.27$$

$$P_i = \frac{1}{\eta} P = 1.75 kW$$

+4

2. (12 points) Gasoline consists of a number of ingredients, these are known as fractions and fall into three chemical series:

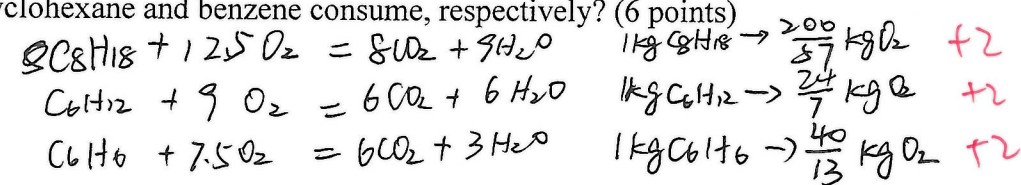
- 1) Paraffins, such as Octane, with a molecular formula of  $C_8H_{18}$ .
- 2) Napthenes, such as Cyclohexane, with a molecular formula of  $C_6H_{12}$ .
- 3) Aromatics, such as Benzene, with a molecular formula of  $C_6H_6$ .

The atomic masses of various elements are known as: H-1, C-12, O-16.

(12)

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| 学院<br>School     |  |

- (1) How much oxygen is required for complete combustion of 1kg octane, cyclohexane and benzene consume, respectively? (6 points)



- (2) Air contains 23% oxygen by mass, please calculate the stoichiometric air-fuel ratios (理论空燃比) of octane and cyclohexane and benzene, respectively. (3 points)

$$AF(\text{C}_8\text{H}_{18}) = \frac{\frac{200}{57} \text{kg O}_2}{1\text{kg C}_8\text{H}_{18} \times 23\%} = 15.25 \quad +1$$

$$AF(\text{C}_6\text{H}_{12}) = \frac{\frac{24}{7} \text{kg O}_2}{1\text{kg C}_6\text{H}_{12} \times 23\%} = 14.91 \quad +1$$

$$AF(\text{C}_6\text{H}_6) = \frac{\frac{40}{13} \text{kg O}_2}{1\text{kg C}_6\text{H}_6 \times 23\%} = 13.38 \quad +1$$

- (3) Suppose the gasoline has 60% octane, 20% cyclohexane and 20% benzene. what is the stoichiometric air-fuel ratio of the gasoline? (3 points)

$$\begin{aligned} AF &= 0.6 AF(\text{octane}) + 0.2 AF(\text{cycl}) + 0.2 AF(\text{ben}) \\ &= 9.15 + 2.982 + 2.676 = 14.808 \quad +3 \end{aligned}$$

3. (16 points) The calculation formula of basic fuel-injection time is as follows:

$$T = \frac{120G}{CZn}$$

where  $G$  is the air flow (g/s),  $C$  is the constant related to fuel injector structure and stoichiometric air-fuel ratio (理论空燃比),  $Z$  is the number of cylinders of the engine,  $n$  is the engine speed (r/min). The speed of a four-cylinder engine is 3000r/min, and the intake air flow rate is 30g/s. Please calculate:

- (1) The amount of intake air of each cylinder per cycle. (4 points)

$$\dot{V} = 3000 \text{r/min} = 50 \text{r/s}$$

$$\text{intake} : \frac{30 \text{g/s} \times 2}{4 \times 50 \text{r/s}} = 0.3 \text{g/r} \quad +4$$

- (2) The basic fuel-injection quantity of each cylinder per cycle. (4 points)

$$\text{Since } F = \frac{G}{Z \cdot \frac{n}{120} \cdot AF \cdot V} = \frac{120G}{CZn}$$

$$\therefore \text{fuel injection} = \frac{0.3}{14.808} = \frac{0.3}{14.7} = 0.02 \text{g/r} \quad +4$$

- (3) The basic fuel-injection time if the injection rate of the injector is 4g/s. (4 points)

$$T_z = \frac{0.02 \text{g/r}}{4 \text{g/s}} = 0.002 \text{s} = 2 \text{ms} \quad +3$$

- (4) The basic fuel-injection time if the EGR (废气再循环) rate is 20%. (4 points)

$$T = T_0 / (1 - 20\%) = 2.5 \text{ms} \quad +0$$