

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	7	23	38								68

Score 7

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 电磁 circuit, and maintain the generator voltage steady through 换向刷.
- The starter consists of 起动机, transmission mechanism (传动机构) and 电动机.
- The engine starting system is mainly composed of 起动机, 电源 and control circuit of the starter (起动机).
- The automotive electric system is characterized by low voltage, DC, _____ and _____.
- There are mainly three types of engine speed sensors: magnetic inductive, 光电式 and 霍尔式 engine speed sensors.
- The spark advance mechanisms of traditional contact-controlled ignition system (触点式点火系统) include 点火提前 and 可控点火.
- Automatic transmission (AT) shifts gear automatically according to _____ and _____.
- EPS system is classified into _____, pinion type electric power steering and _____ according to the position of the power mechanism.
- ESP system integrates the basic functions of electronic brake force distribution, _____ and _____.
- Automotive electronic cruise control system uses 车速 as the feedback signal and keep the automobile speed steady by adjusting 节气门开度.

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

- What are the basic requirements of the gasoline engine ignition system? (6 points)

答: ①要有较高的次级电压
击穿电压应能电离产生电火花。击穿电压与发动机工况、火花塞电极极性和温度、火花塞的间隙和形状有关。
②要有足够的点火能量。
③点火时间要合适。

- 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)

答: ①光电式转向盘转角传感器将转向盘的转角传递给控制端 ECU, ECU 对汽车的转向情况及时角做出判断, 并判断车身是否有侧倾趋势。
②光电式转向盘转角传感器上有遮光盘, 遮光盘上有微孔, 其与转向盘轴一起转动, 可通光电式转向盘转角传感器输出的脉冲个数计算转向盘转角。
③传感器会产生两个信号, 其大小相同, 相位相差 90°。可经过 A 信号沿下降沿时, B 信号对应电平高电平判断转向, A 下降时, B 为高电平则右转, A 下降时, B 为低电平则左转。

- 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)

答: ECU 根据发动机转速和节气门开度传感器传输信号进行分析并向执行器传达命令调节节气门开度等精确控制喷油时间。
喷油量 = 基本喷油量 + 修正值, 通常由喷油时间控制喷油量。
基本喷油量是空气流量计, 发动机转速传感器传给 ECU, 喷油量可由公式计算 $T_s = \frac{120 G}{C Z n}$ 决定, 也可根据图获得。
修正喷油量主要通过进气温度修正, 怠速暖机修正、汽车加速修正, 汽车减速修正, 大负荷工况修正等进行修正调节, 以得到精确控制。

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

答: 蓄电池电压过高时, 节气门辅助时间降低, 以防止电压过大对电子控制系统电路损害。

蓄电池电压小时, 应增大辅助时间, 使电路获得足够的电流。

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

答: 液力传动式自动变速器由以下三部分组成。

① 液力传动 主要装置是液力变矩器, 它可以进行动力的传递, 起到减速增矩的作用

② 机械辅助变速 主要由齿轮变速器和换挡执行机构组成, 进行一步实现减速增矩, 并将动力向传动系统传递

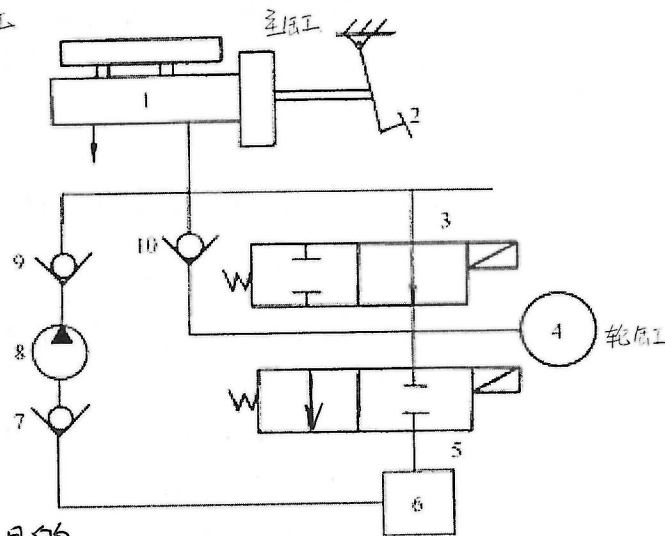
③ 自动控制 主要由电子控制系统和液压控制系统, 对传来的信号做出分析判断, 并传递给执行器。

- 液力传动式自动变速器可详细分为: ①液力变矩器 ②齿轮减速器 ③油路供油及液压调节装置 ④液压控制装置 ⑤锁止离合器控制装置 ⑥传感器和开关 ⑦电子控制系统及其电路。
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)

答: 3: 常开电磁阀
5: 常闭电磁阀
8:

工作状态: 减压工作状态。

5通电后, 常开电磁阀将制动主缸与制动轮缸通路阻断, 制动轮缸与储液器通路打开, 液体流向储液器从而达到减压目的。



+4

Score 38

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)

解: 由题意知: 减速机构的传动比 $i=10:1$

$$M_{\text{发}} = 360 \text{ N}\cdot\text{m} \quad \text{由 } P = \frac{Mn}{9550} \text{ 可得 } M_{\text{发}}:M_{\text{起}} = 10:1$$

$$\text{则 } M_{\text{起}} = 360 \times \frac{1}{10} = 36 \text{ N}\cdot\text{m}$$

+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)

解: 发动机最小转速 $n=100 \text{ rpm}$

$$\text{由 } P = \frac{Mn}{9550} \text{ 可得 } M_{\text{起}} = \frac{M_{\text{发}} \times n_{\text{发}}}{n_{\text{起}}} = 10 \text{ N}\cdot\text{m}$$

$\therefore$ driving torque 为 $10 \text{ N}\cdot\text{m}$

+3

- (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)

解: $n_{\text{发}} = 100 \text{ rpm} \quad M_{\text{发}} = 100 \text{ N}\cdot\text{m}$

$$P_{\text{发}} = \frac{M_{\text{发}} \cdot n_{\text{发}}}{9550} = \frac{100 \times 100}{9550} = 1.047 \text{ kW}$$

$$\because \eta = 60\%$$

$$\therefore P_{\text{起}} = \frac{P_{\text{发}}}{60\%} = 1.745 \text{ kW}$$

+4

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

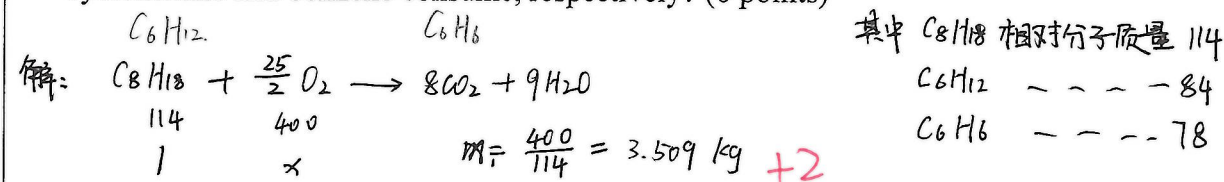
- 1) Paraffins, such as Octane, with a molecular formula of C_8H_{18} .
- 2) Napthenes, such as Cyclohexane, with a molecular formula of C_6H_{12} .
- 3) Aromatics, such as Benzene, with a molecular formula of C_6H_6 .

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

(12)

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



同理, 例出方程式可以算出

C_6H_{12} 消耗氧气: $m_2 = \frac{288}{84} = 3.428 \text{ kg}$ +2

C_6H_6 消耗氧气: $m_3 = \frac{15 \times 2 \times 16}{6 \times 12 + 6} = \frac{240}{78} = 3.076 \text{ kg}$ +2

(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)

解: C_8H_{18} : 消耗空气: $x_1 = \frac{m_1}{23\%} = 15.256 \text{ kg}$ 理论空燃比: $\frac{\text{空气质量}}{\text{燃料质量}} = 15.256$ +1

C_6H_{12} : 消耗空气: $x_2 = \frac{m_2}{23\%} = \frac{3.428 \text{ kg}}{23\%} = 14.904 \text{ kg}$ 理论空燃比: 14.904 +1

C_6H_6 : 消耗空气: $x_3 = \frac{m_3}{23\%} = \frac{3.076 \text{ kg}}{23\%} = 13.374 \text{ kg}$ 理论空燃比: 13.373 +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)

解: 假设汽油为 1kg 则 C_8H_{18} : 0.6kg C_6H_{12} : 0.2kg C_6H_6 : 0.2kg

C_8H_{18} 消耗空气量: $y_1 = 0.6 \times 15.256 = 9.1536 \text{ kg}$

C_6H_{12} 消耗空气量: $y_2 = 0.2 \times 14.904 = 2.9808 \text{ kg}$ +3

C_6H_6 消耗空气量: $y_3 = 0.2 \times 13.373 = 2.6746 \text{ kg}$

消耗总的空气量 $y = y_1 + y_2 + y_3 = 9.1536 + 2.9808 + 2.6746 = 14.809 \text{ kg}$

理论空燃比 $\frac{m_{\text{空气}}}{m_{\text{燃料}}} = 14.809$

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

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

16

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) 每缸每循环

解: 空气流量 $G = 30 \text{ g/s}$

发动机转速 $n = 3000 \text{ r/min} = 50 \text{ r/s}$

一个工作循环 发动机转两圈, 发动机一个工作循环时间 $t = 0.04 \text{ s}$ +4

进气量 (每缸每循环) $Q = 30 \times 0.04 \times \frac{1}{4} = 0.3 \text{ g}$

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

解: 由第2题的理论空燃比 14.809

则燃油质量: $m = \frac{0.3}{14.809} = 0.0202 \text{ g}$ +4

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

解: 喷射速率 4g/s

$T = \frac{0.0202 \text{ g}}{4 \text{ g/s}} = 5.05 \times 10^{-3} \text{ s}$ +4

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

解: 废气再循环速率 20%

$T = \frac{5.05 \times 10^{-3}}{1 + 0.2} = 4.208 \times 10^{-3} \text{ s}$ +4