

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	5	17	34								56

Score 5

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 整流器 circuit, and maintain the generator voltage steady through 稳压器.
- The starter consists of 直流电动机 transmission mechanism (传动机构) and 电动机.
- The engine starting system is mainly composed of 启动电源, 启动机 and control circuit of the starter (起动机).
- The automotive electric system is characterized by low voltage, DC, 稳定 and 可靠.
- 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 分电器 and 断电器.
- Automatic transmission (AT) shifts gear automatically according to 车速 and 油门位置.
- EPS system is classified into 机械式 pinion type electric power steering and 电子式 according to the position of the power mechanism.
- ESP system integrates the basic functions of electronic brake force distribution, EBD and ABS.
- Automotive electronic cruise control system uses 速度传感器 as the feedback signal and keep the automobile speed steady by adjusting 节气门开度.

Score

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

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

Solution:

- 有足够的次级电压;
- 点火能量要充足;
- 点火时间要适当.

+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)

Solution:

如图所示, 光电式转向盘转角传感器通过将转向盘转角转换为 A、B 两个信号。
当 A 信号为低电平 B 信号为高电平时, 表现为向右转向; 当 A 信号为高电平 B 信号为低电平时为向左转向; 而 A、B 均为高或低电平时表现为不转向。

+4

- 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)

Solution:

ECU 根据各传感器输入的信号来判断发动机所处的工况和状态, 来控制喷油量。随着信号的变化, 不断对喷油量进行修正, 合理控制喷油时间, 使达到最佳空燃比, 以此来精确控制燃油喷射量。

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

Solution: ①. 蓄电池电压过高, 会导致电器损坏.
②. 电压过低会导致, 起动机等无法工作
③. 要维持合适且稳定的电压, 保证起动机等电器能够正常工作.

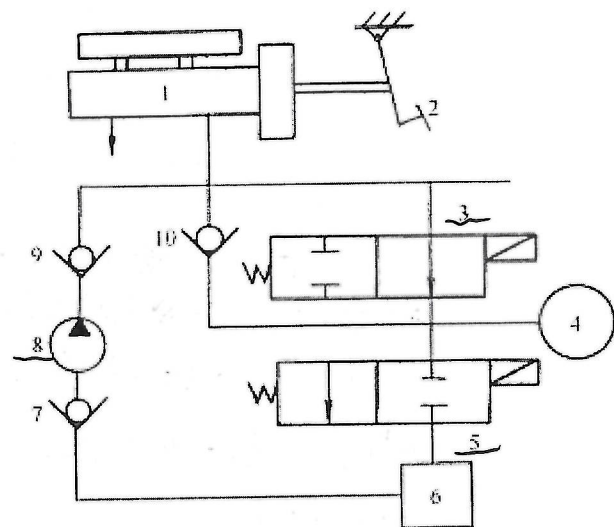
5. What are the components of hydraulic-drive automatic transmission (AT) and the functions of these components? (6 points)

Solution: 包括
①. 液力传动装置: 将发动机的功率传递给齿轮变速器.
②. 辅助变速装置: 进一步增矩.
③. 自动控制系统: 完成换挡, 锁止系统的自动控制

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)

Solution: 3- 控制阀;
5- 控制阀;
8- 传感器;

由图中各元器件位置和工作状态可判断该制动压力调节器处于制动状态.



+1

Score 34

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)

Solution: $T_{min} = 360 \div 10 = 36 \text{ N}\cdot\text{m}.$

+3

即为 36 N·m.

- (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)

Solution: $100 \text{ N}\cdot\text{m} \div 10 = 10 \text{ N}\cdot\text{m}.$

$1000 \text{ rpm} \times 10 = 10000 \text{ rpm}.$

+3

即为 10 N·m.

- (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)

Solution: $P_1 = \frac{T_{eq} \cdot n}{9550} = \frac{10 \times 1000}{9550} = 1.067 \text{ kW}.$

$P = P_1 / 60\% = 1.765 \text{ kW}.$

+4

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

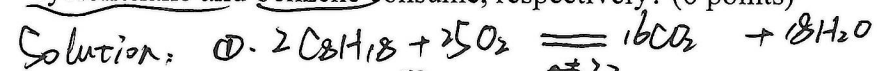
- 1) Paraffins, such as Octane, with a molecular formula of C_8H_{18} .
- 2) Napthenes, such as Cyclohexane, with a molecular formula of C_6H_{12} .
- 3) Aromatics, such as Benzene, with a molecular formula of C_6H_6 .

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

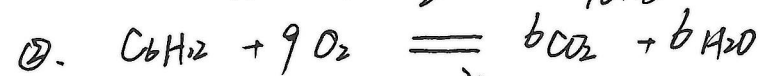
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(1) How much oxygen is required for complete combustion of 1kg octane, cyclohexane and benzene consume, respectively? (6 points)



$$m(O_2)_1 = 1 \times \frac{25}{2} \times \frac{32}{96+18} = 3.509g \quad +2$$



$$m(O_2)_2 = 1 \times 9 \times \frac{32}{72+12} = 3.429g \quad +2$$



$$m(O_2)_3 = 1 \times \frac{15}{2} \times \frac{32}{72+6} = 3.077g \quad +2$$

(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)

Solution: ①. C_8H_{18} :

$$3.509 / 23\% = 15.26 \quad +1$$

②. C_6H_{12} :

$$3.429 / 23\% = 14.91 \quad +1$$

③. C_6H_6 :

$$3.077 / 23\% = 13.38 \quad +1$$

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

Solution:

理论空燃比:

$$15.26 \times 60\% + 14.91 \times 20\% + 13.38 \times 20\%$$

$$= 14.81 \quad +3$$

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: $V_{缸}$

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

Solution: $3000r/min = 50r/s \Rightarrow$ 每秒钟有25个循环.

$$30 \div 25 \div 4 = 0.3g.$$

即每缸每循环0.3g. $+4$

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

Solution: ~~每缸每循环喷油量~~
 以理论空燃比为14.7计算.

$$0.3g / 14.7 = 0.0204g \quad +4$$

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

Solution: $V_{缸}$ 每秒喷油量 $0.0204 \times 4 \times 25 = 2.04g$

$$t = \frac{2.04g}{4g/s} = 0.51s. \quad +4$$

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

Solution: $t / (1+20\%) = 0.425s.$

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