

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	11	28	34								73

Score

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 三相全波整流 circuit, and maintain the generator voltage steady through 蓄电池.
- The starter consists of 直流发电机, transmission mechanism (传动机构) and 控制电路.
- The engine starting system is mainly composed of 蓄电池, 起动机 and control circuit of the starter (起动机).
- The automotive electric system is characterized by low voltage, DC, 负极搭铁 and 串联.
- 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 配电器 and 分电器.
- Automatic transmission (AT) shifts gear automatically according to 车速 and 节气门开度.
- EPS system is classified into 转向助力, pinion type electric power steering and 齿条式转向 according to the position of the power mechanism.
- ESP system integrates the basic functions of electronic brake force distribution, 牵引力调节 and 驱动防滑.
- 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

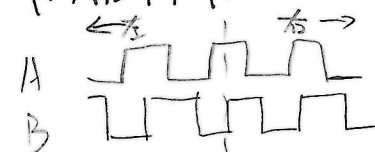
II. Short-answer questions (42 points for 6 questions)

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

- 产生足够的次级电压: 次级电压足够高, 使击穿电压能击穿空气产生火花
- 点火能量充足: 使电火花有足够的能量使混合气充分燃烧
- 点火时间适当: 在上止点前 10-15° 使火花到最大值

- 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)

传感器上的遮光盘上均匀布置透光孔, 转向盘转动可通过光耦合器上的脉冲数个数得到;
方向的识别是根据两个相位相差 90° 的 A、B 光耦合器得到. A 在下降沿 B 为高电位则为右转, 反之为左转.



- 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)

通过应用相对喷油压力调节器, 来调节喷油量.
由于油的温度的变化, 会影响油的密度, 从而引起喷油量的误差, 相对压力调节器会根据燃烧的情况来负反馈调节喷油压力的大小, 使喷油量恢复最佳空燃比.
相对喷油压力调节器精度高于绝对压力调节器

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

电压过小或过大影响:

传感器中对测量对象的识别问题
控制单元中对信号处理的准确性
执行器中可能无法完成ECU指定的任务

例如电压过小时, 传统点火系统中 线圈产生次级电压可能过小
达不到击穿电压使发动机无法正常点燃运转.

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

液压传动机构: 动力源油泵, 由泵轮、涡轮、蜗轮组成, 可以
断开或传递飞轮的转矩到变速器

辅助传动机构: 行星齿轮机构和离合器等组成, 可以实现换挡,
形成不同传动比

电子控制系统: 控制最佳换挡点, 换挡控制 和 模式
选择

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)

3. 5是两位四通电磁阀

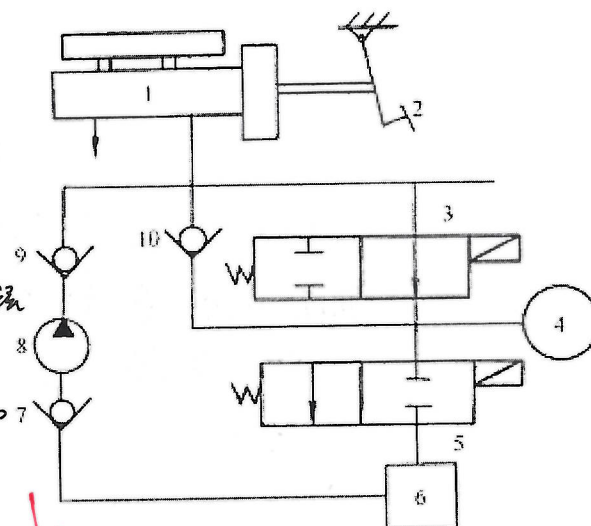
8是单向电磁阀

3通5不通

液体从3到5循环流动, 5-5无法流

通, 最终可以给提供液压

故是增压或常压或常通有流状态



X 6

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)

因为减速机构作用, 扭矩增大10倍.

$$\therefore T_m = \frac{360}{10} = 36 \text{ Nm}$$

+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)

$$T_d = \frac{100}{10} = 10 \text{ Nm}$$

+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)

$$W = \frac{10 \text{ Nm} \cdot \text{m}}{60\%} = 16.67 \text{ Nm}$$

$$P = \frac{W \cdot n}{9550} = \frac{16.67 \times 1000}{9550} = 1.75 \text{ kW}$$

+4

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

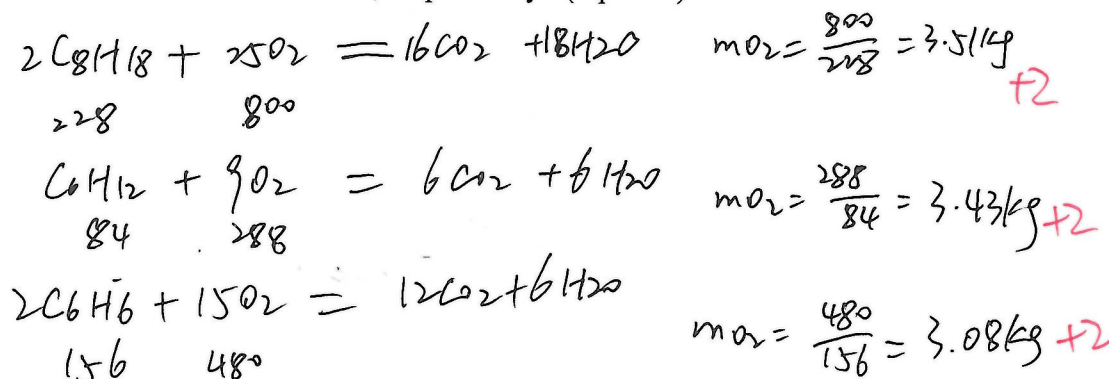
- 1) Paraffins, such as Octane, with a molecular formula of C_8H_{18} .
- 2) Napthenes, such as Cyclohexane, with a molecular formula of C_6H_{12} .
- 3) Aromatics, such as Benzene, with a molecular formula of C_6H_6 .

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

(12)

姓名 Name	学号 Student ID	专业班级 Class	学院 School
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(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)

$$\begin{aligned}
 C_8H_{18} \text{ 空燃比} &= \frac{m_{\text{空}}}{m_{\text{燃}}} = \frac{\frac{3.51}{23\%}}{1} = 15.26 \quad +1 \\
 C_6H_{12} \text{ 空燃比} &= \frac{\frac{3.43}{0.23}}{1} = 14.91 \quad +1 \\
 C_6H_6 \text{ 空燃比} &= \frac{\frac{3.08}{0.23}}{1} = 13.39 \quad +1
 \end{aligned}$$

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

$$\begin{aligned}
 \text{空燃比} &= 15.26 \times 60\% + 14.91 \times 20\% + 13.39 \times 20\% \\
 &= 14.82 \quad +3
 \end{aligned}$$

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

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

(12)

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)

$$3000 \text{ r/min} \rightarrow 15 / 0.025$$

$$m_A = 30g/s \times 0.025 \times \frac{1}{4} \times 2 = 0.39 \quad +4$$

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

$$m_f = \frac{m_A}{\text{理论空燃比}} = \frac{0.3}{14.7} = 0.02g \quad +4$$

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

$$t = \frac{0.02g}{4g/s} = 5 \times 10^{-3}s = 5ms \quad +4$$

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

$$t = \frac{0.02g}{4g/s \cdot (1-20\%)} = 6.25 \times 10^{-3}s = 6.25ms \quad 0$$