

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	13	37	38								88

Score 13

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 电磁开关.
- The engine starting system is mainly composed of 起动机, 起动电源 and control circuit of the starter (起动机).
- The automotive electric system is characterized by low voltage, DC, 单线制 and 负极搭铁 two power.
- There are mainly three types of engine speed sensors: magnetic inductive, 霍尔式速度传感器 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 离心式点火提前调节装置 and 真空式点火提前调节装置.
- Automatic transmission (AT) shifts gear automatically according to 换挡阀 and 换挡电磁阀.
- EPS system is classified into 液压式助力转向 pinion type electric power steering and 电动式EPS according to the position of the power mechanism.
- ESP system integrates the basic functions of electronic brake force distribution, 电子转向系统 and 发动机控制系统.
- Automotive electronic cruise control system uses 车速传感器 as the feedback signal and keep the automobile speed steady by adjusting 节气门开度.

Score 37

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

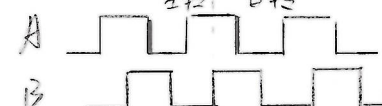
- What are the basic requirements of the gasoline engine ignition system? (6 points)

Solution: ①产生足够高的点火电压
②具有足够高的点火能量
③点火时间要合适

+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: 光电式转向盘转角传感器通过有一上面分布有透光槽的遮光板, 随着汽车转向盘转动带动遮光板转动, 在光电耦合器上产生一系列脉冲信号, 通过脉冲信号的个数判断方向盘转角。
其判断方向时产生两组这样的脉冲信号, 两组脉冲信号脉冲宽度相同, 相位相差90°, 如下, 当A脉冲信号处于下降沿时, B信号为高电平, 则此时为左转, 若此时B位于高电平, 此时为右转。



+6

- 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: 先根据发动机转速传感器、进气压力传感器或空气流量传感器确定基本喷油量, 然后用公式计算法 ($T = \frac{120Ga}{CZ\eta}$) 或查表法确定基本喷油时间, 然后再根据各相关传感器对喷油量作修正。

- 进气温度修正
- 起动时喷油量修正
- 起动后喷油量修正
- 怠速喷油量修正
- 加速时喷油量修正
- 减速时喷油量修正
- 大负荷喷油量修正
- 燃油高温喷油量修正
- 蓄电池电压喷油量修正
- 混合气浓度反馈喷油量修正
- 自适应修正

控制喷油时间后, 喷油量还可能受燃油压力、燃油密度、喷油器开启速度等影响。
应①用燃油温度传感器测量燃油温度, 随温度升高, 燃油密度下降, 喷油时间应延长。
②检测蓄电池电压, 蓄电池低时, 开启速率较慢, 应延长喷油时间。
③使用相对油压调节器。

+8

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

Solution: ① 电压过高: 喷油泵开启时间过长, 相同喷油时间内喷油量减少
② 电压不稳定会使发动机控制系统相应控制不稳定
③ 电压不稳定会使故障记忆电路的故障代码和修正系数被清除。
④ 电压过高可能会使发动机电控系统元件损坏。

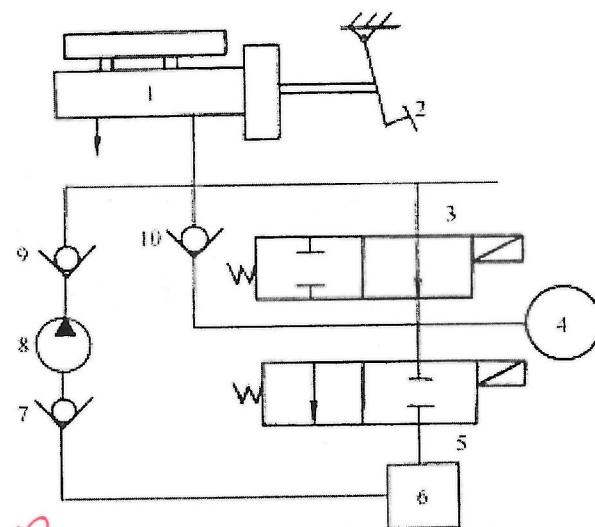
5. What are the components of hydraulic-drive automatic transmission (AT) and the functions of these components? (6 points)

Solution: ① 自动控制装置: 包括液压控制装置和电子控制装置
功能: 用于调整液力变矩器内液压, 并跟据传感器、节气门位置传感器等传感器传入的信号和档位开关、换位开关的位置等, 确定计算、分析确定此时应有档位, 并通过执行机构实现换挡
② 液力驱动装置: 液力变矩器
功能: 实现一定范围内的减速增矩和无级变速, 必要时可通过锁止离合器锁止来提高传动效率。
③ 机械辅助变速装置: 包括行星齿轮变速机构和换挡执行机构
功能: 跟据控制装置信号实现换挡, 增加AT变速范围。

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表示常开电磁阀
5表示常闭电磁阀
8表示回油泵

图中此状态处于普通制动或增压状态



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)

Solution: (1) $T_{stall} = \frac{360 \text{ N}\cdot\text{m}}{10} = 36 \text{ N}\cdot\text{m}$

(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 (2) $T_{driving} = \frac{100 \text{ N}\cdot\text{m}}{10} = 10 \text{ N}\cdot\text{m}$

(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: $P = \frac{T_{driving} \cdot n_s}{9550 \eta_T} = \frac{10 \times 100 \times 10}{9550 \times 60\%} \text{ kW} = 1.745 \text{ kW}$

So it requires 1.745 kW at least.

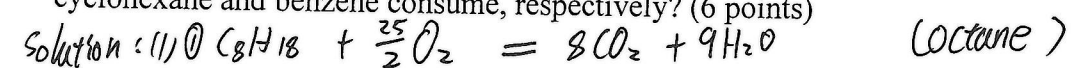
2. (12 points) Gasoline consists of a number of ingredients, these are known as fractions and fall into three chemical series:

- 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 .

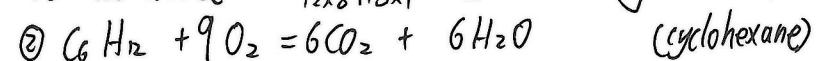
The atomic masses of various elements are known as: H-1, C-12, O-16.

学院 School		专业班级 Class	学号 Student ID	姓名 Name
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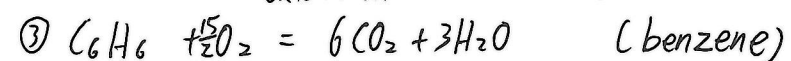
- (1) How much oxygen is required for complete combustion of 1kg octane, cyclohexane and benzene consume, respectively? (6 points)



So we need $\frac{1}{12 \times 8 + 18 \times 1} \times \frac{25}{2} \times 16 \times 2 \text{ kg} = 3.5 \text{ kg}$ Oxygen. +2



So we need $\frac{1}{6 \times 12 + 12 \times 1} \times 9 \times 16 \times 2 \text{ kg} = 3.43 \text{ kg oxygen.}$



So we need $\frac{1}{6 \times 12 + 6 \times 1} \times \frac{15}{2} \times 16 \times 2 \text{ kg} = 3.077 \text{ kg oxygen.}$ +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)

points)

Solution: ① octane : $\frac{3.51}{23\%} = 15.26$ +1

② cyclohexane : $\frac{3.43}{2.3\%} = 14.91$ +1

③ benzene : $\frac{3.077}{23\%} = 13.38$ +

- (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: The stoichiometric air-fuel ratio of the gasoline:

$$\frac{3.51 \times 60\% + 3.43 \times 20\% + 3.077 \times 20\%}{23\%} = 14.81$$

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

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

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)

Solution: (1) 1秒内发动机转了 $3000 \div 60 \text{ r} = 50 \text{ r}$

50转等于 $\frac{50}{2} = 25$ 个 ~~半~~ 循环

1秒内吸入30g空气与约4个缸

② 每缸每循环进水量为 $\frac{30}{25 \times 4} g = 0.3 g$.

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

Solution: (2) 理论空燃比为 14.7, 若该发动机用的是理论空燃比, 则每循环喷油量为 $\frac{0.3}{14.7} = 0.02g$

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

Solution: (3) $t = \frac{0.02}{4} \text{ s} = 0.005 \text{ s}$

So the basic fuel-injection time is 0.005 s .

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

Solution: ~~焓变~~ 实际 EGR率 = $\frac{\text{EGR量}}{\text{新鲜空气量} + \text{EGR量}} \times 100\%$

此时实际进入空气量为 $0.3 \times (1 - 20\%) g = 0.24 g$

此时口喷量为 $\frac{0.24}{14.7} g = 0.016g$

喷射时间为 $\frac{0.016}{4} = 0.004 \text{ s}$