

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	26	32								69

Score

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

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- Modern automobiles generally adopt three-phase synchronous alternator (三相同步交流发电机), transfer AC into DC via 变压器 circuit, and maintain the generator voltage steady through 稳压器.
- 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, 发电机 and control circuit of the starter (起动机).
- The automotive electric system is characterized by low voltage, DC, 负极搭铁 and _____.
- There are mainly three types of engine speed sensors: magnetic inductive, 光电式 and 霍尔效应式 engine speed sensors.
- The spark advance mechanisms of traditional contact-controlled ignition system (触点式点火系统) include 分组式触点点火 and 独立式触点点火.
- Automatic transmission (AT) shifts gear automatically according to 节气门开度, 车速传感器 and 当前工况最佳换挡点.
- EPS system is classified into 转向辅助式, pinion type electric power steering and 齿条助力式 according to the position of the power mechanism.
- ESP system integrates the basic functions of electronic brake force distribution, 转向稳定性 and _____.
- 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

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

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

答: ① 工作穩定

② 次级电压高

③ 点火能量大

④对火花塞积炭不敏感

⑤ 不易干扰无线电

④可以根据不同情况修正点火提前角

① 适应各种工况,使点火控制在接近爆燃而不爆燃

⑧精确控制点火时间

+ 6

2. 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. 角度: 传感器上有均匀分布、大小相同的透光孔, 当转向盘转角变化时, 遮光器也旋转, 光电耦合器输出脉冲信号, 根据输出的脉冲信号个数确定角度

(2) 方向: 有 A、B 两信号, 相位差为 90° 。当 A 信号下降沿时, 若 B 信号为高

电平, 是右转; B信号为低电平, 是左转。
左转 ← 180° → 右转

 $+$

A 

B 

3. 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：电子控制燃油喷射系统中ECU接收各传感器信号确定当前发动机工况，根据储存在RAM中的最佳空燃比确定基本喷油量，再由温度传感器、转速传感器等计算修正喷油量，综合得到最终喷油量。喷嘴截面面积和喷油压力一定，控制喷油时间即控制喷油量。

+ 2

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

答: 蓄电池电压过高, 发动机电控电路可能短路被烧毁。

蓄电池电压过低, 发动机电控电路没有足够的工作电压驱动工作。

蓄电池容量: $C = (610 - 810) \frac{A \cdot h}{U}$, 单位 (A·h)

因此, 发动机电控电路需要合适的蓄电池电压

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

答: 液力变矩器: 传递动力并实现一定范围内的无级变速

辅助变速: 机械齿轮传动, 扩大传动比范围, 提高汽车适应性

电子控制器: 根据传感器信号, ECU 运算处理后输出控制信号, 执行机构换挡

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. 二位二通常闭电磁阀

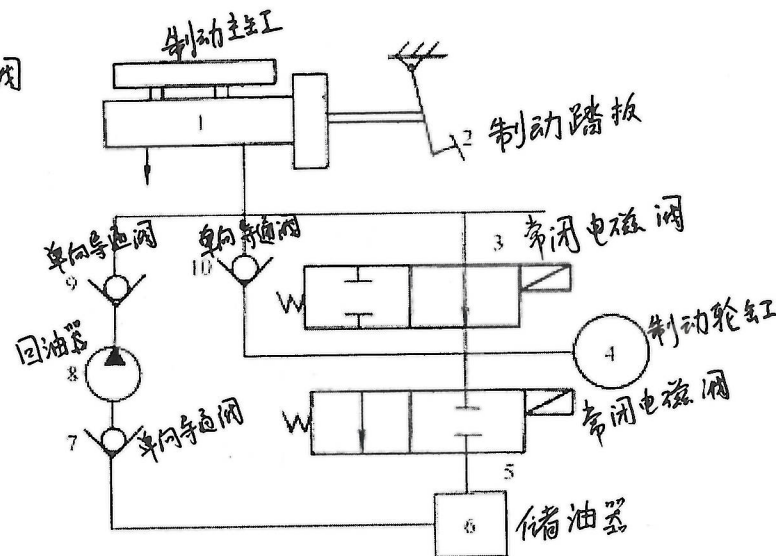
8. 回油器

2. 增压或普通制动;

制动主缸与制动轮缸连通, 可增大制动压力;

制动踏板力与制动轮缸

直接相连, 普通制动



Score 32

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: 减速增矩

$$T_{min} = \frac{360}{10} = 36 \text{ Nm}$$

+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)

减速增矩, 只用克服动摩擦力矩

$$T_{min} = \frac{100}{10} = 10 \text{ Nm}$$

+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)

$$P' = \frac{T \times n}{9550} = \frac{10 \times (100 \times 10)}{9550} = 1.05 \text{ kW}$$

$$P = \frac{P'}{\eta} = \frac{1.05}{60\%} = 1.75 \text{ kW}$$

+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} .

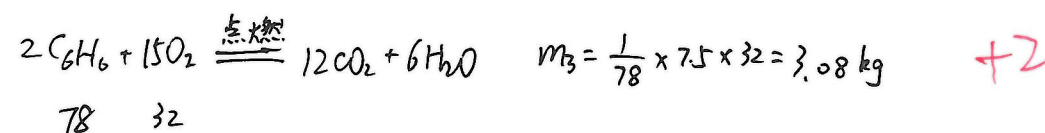
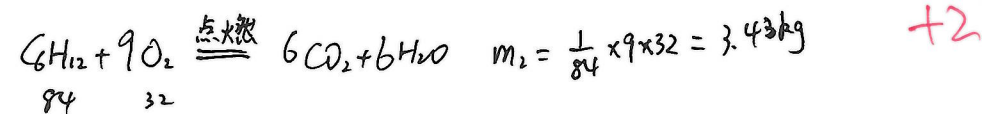
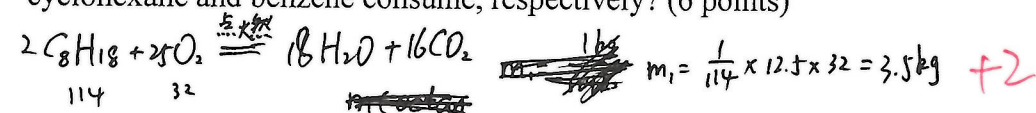
2) Napthenes, such as Cyclohexane, with a molecular formula of C_6H_{12} .

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.

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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)

$(\frac{A}{F})_1 = \frac{3.5 \div 23\%}{1} = 15.22$ octane +1

$(\frac{A}{F})_2 = \frac{3.43 \div 23\%}{1} = 14.91$ cyclohexane +1

$(\frac{A}{F})_3 = \frac{3.08 \div 23\%}{1} = 13.39$ benzene +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)

$\frac{A}{F} = \frac{(3.5 \times 60\% + 3.43 \times 20\% + 3.08 \times 20\%) \div 23\%}{1} = 14.79$ +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:

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

解: $3000r/min = 50r/s$

曲轴转两圈为一个循环, $2r/cycle$

$\frac{2}{50} = \frac{1}{25} = 0.04s/cycle$

又因为一个循环四缸每缸进气

$0.04 \times 30 \div 4 = 0.3g/cycle$ +4

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

解: $\frac{A}{F} = 14.8$

$F = \frac{A}{14.8} = \frac{0.3}{14.8} = 0.02g/cycle$ +4

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

解: $0.04s/cycle \Rightarrow 1s$ 经历 25 个循环

$T = \frac{120G}{CZn} = \frac{120 \times 4}{14.8 \times 4 \times 3000} = 2.7ms$ ○

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

解: Exhaust Gas Recirculation +2

$2.7 \times (1 - 20\%) = 2.16ms$