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Wuhan University of Technology, Examination Paper (A)

Academic Year 2018-2019 Second Semester Vehicle Design Closed Book

Time: 120minutes Credit: 5 Total Marks: 100 June 2019

Question	I	II	III	IV	V	VI	VII	VIII	Total	Teacher
Full marks	14	13	13	12	12	12	12	12	100	
Marks	8	8	5	7	12	1	4	6	51	

Marks 8

Question I Overall Design

The battery electric vehicle parameters are as follows: total vehicle mass m is 1800kg, air resistance coefficient C_D is 0.3, frontal area A is $2.8m^2$, rolling resistance coefficient f is 0.02, transmission efficiency η_T is 90%, wheel radius r is 0.288m, the maximum vehicle speed $u_{a_{max}}$ is 120km/h, and the acceleration of gravity g is $9.8m/s^2$. The layout of the drive system is shown in Figure 1, where D is the differential, FG is final drive and M is the motor.

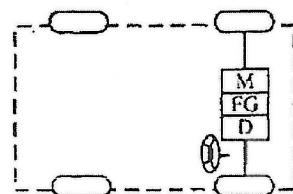


Fig. 1 Layout of Drive System for Battery Electric Vehicle

1. Please calculate the required motor power in order to achieve the maximum vehicle speed. (5 marks)

2. Please describe the name, advantages and disadvantages of its drive system layout (驱动系统布置型式). (9 marks)

解: 1): 由题得: $P_m = \frac{u_a}{3600 \cdot \eta_T} \times (G \cdot f + \frac{C_D A \cdot u_a^2}{21.15})$

$$P_m = \frac{120}{3600 \times 0.9} \times (1800 \times 9.8 \times 0.02 + \frac{0.3 \times 2.8 \times 120^2}{21.15}) \approx 34.25 kW$$

2): 驱动系统布置型式有: 前置前驱型、前置后驱型、后置前驱型、后置后驱型, 前置前驱型目前是应用最广泛的, 多用于小轿车

Marks 8

Question II Clutch Design

1. Please indicate which is the push-type (推式) diaphragm spring clutch and which is the pull-type (拉式) diaphragm spring clutch in Figure 2. Please explain the reason why the pull-type diaphragm spring clutch is better than the push-type diaphragm spring clutch. (5 marks)

答: a是推式离合器;
b是拉式离合器。
拉式离合器更好的原因有: ①: 如图所示, 拉式离合器结构紧凑, 占用空间小;

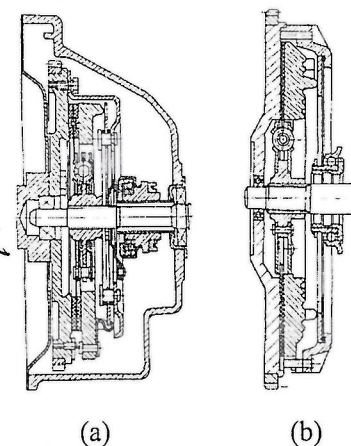
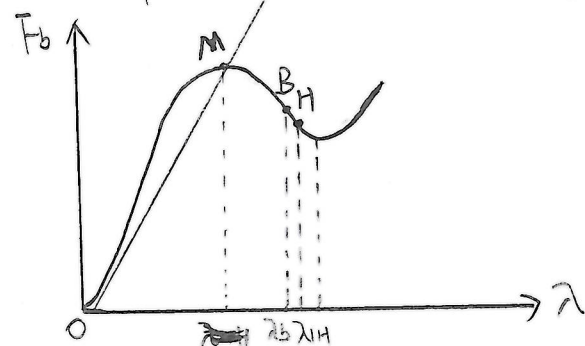


Fig. 2 Diaphragm Spring Clutch

2. Please draw the elastic characteristic curve (弹性特性曲线) of diaphragm spring, describe its advantages, and illustrate how to determine the suitable position of its working point. (8 marks)

解: 膜片弹簧的弹性特性曲线如下:



最合适的工作点(B)的位置应该位于M与H之间, 并尽量靠H点, 这样才能使其达到最大摩擦限度时压紧力变化不大, 同时松离合器踏板时收紧力不会太大。

Marks	5
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Question III Transmission Design

The transmission of Jetta car is shown in Figure 3. Whether is it a two-shaft transmission or a three-shaft transmission? How many forward gears (前进挡) does it have? What kind of shift mechanism (换挡机构) is used in each gear (各挡) including reverse gear (倒挡)? Please mark the position of each gear in Figure 3 and draw the transmitting route (传动路线) of the third gear (III 挡). (13 marks)

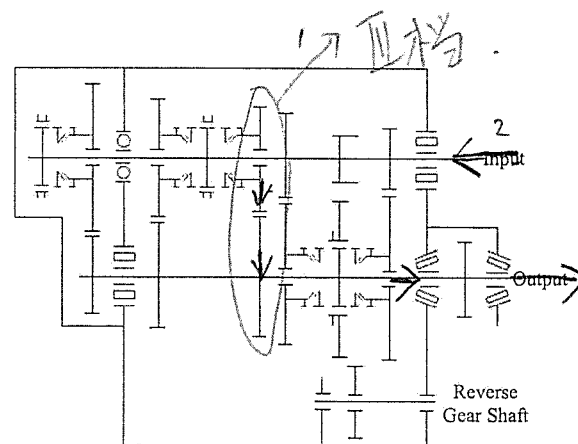


Fig. 3 Schematic Diagram of Transmission of Jetta Car

解: 1): 该变速器为双轴式变速器; 1
 2): 它有五个前进挡; 1
 3):
 4): 如图所示.

Marks	7
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Question IV Universal Joint and Transmission Shaft Design

1. What type of universal joint (万向节) is used in Figure 4? What are the conditions for their constant speed transmission (等速传动)? (5 marks)
2. What is the critical speed (临界转速) of transmission shaft (传动轴)? How to calculate it? When the vehicle wheelbase (轴距) needs to be increased greatly, how to adjust the structure of the transmission shaft? (7 marks)

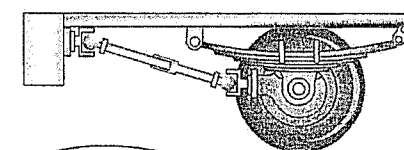


Fig. 4 Schematic Diagram of Rear Wheel Drive System

答: 1. 图4中的是十字轴式万向节, 它等速传动的条件是:
 ①: 两万向节的夹角相等; 2
 ②: 传动轴所连接的两万向节叉在同一平面内. 乙

答: 2. 传动轴的临界转速为: 传动轴所能传递的^{稳定}最大转速而不至于断裂; 可根据轴杆内部的最大应力来计算得到; 乙

Marks

(2)

Question V Drive Axle Design

1. Please describe the offset type (偏移类型) of the hypoid gear (双曲面齿轮) of the final drive (主减速器) in Figure 5, the helix angle direction (旋向) of the driving gear (主动齿轮) and the driven gear (从动齿轮), and the direction of the axial force (轴向力) acting on the driving gear. (4 marks)

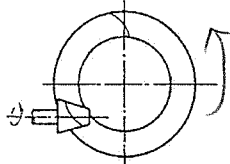


Fig. 5 Hypoid Gear Drive

2. A truck uses a friction disc type differential (摩擦片式差速器), and its locking coefficient k equals 0.6. One wheel 1 of the drive axle is on the snow-covered pavement, and its road adhesion coefficient $\phi_{\min}$ equals 0.2. Another wheel 2 of the drive axle is on the wet concrete pavement, and its road adhesion coefficient $\phi_{\max}$ equals 0.8. The drive axle load G_2 equals 17500N. Please calculate the maximum driving force of this drive axle. (8 marks)

答. 1. 图中的主减速器的双曲面齿轮为上偏置型; 主动齿轮的旋向为右旋, 从动齿轮的旋向为左旋; 从动轮的轴向力从纸面外部垂直指向内部 (即从动轮小端垂直指向大端, 与主动轮有分离趋势)。

2. 解: 依题意: $\frac{F_2}{F_1} = \frac{1+k}{1-k} = \frac{1.6}{0.4} = 4. \Rightarrow F_2 = 4F_1.$

这个驱动桥的最大驱动力:

$$\begin{aligned} F &= F_1 + F_2 = 5F_1 = 5 \times \frac{G_2}{2} \times \phi_{\min} \\ &= 5 \times \frac{17500}{2} \times 0.2 \\ &= 87500 \text{ N}. \end{aligned}$$

Marks

Question VI Suspension Design

1. What is the basis (依据) for choosing different guiding mechanisms (导向机构) for suspension (悬架)? (7 marks)

2. What kind of guide mechanism is usually suitable for the front suspension of ordinary car? Explain the reason. (5 marks)

1. 答: 为汽车悬架选择导向机构时, 首先要保证汽车有良好的操纵稳定性, 也要保证汽车制动和加速行驶时不会有过大的车身倾斜, 还要保证汽车转向时的侧倾角不会太大。

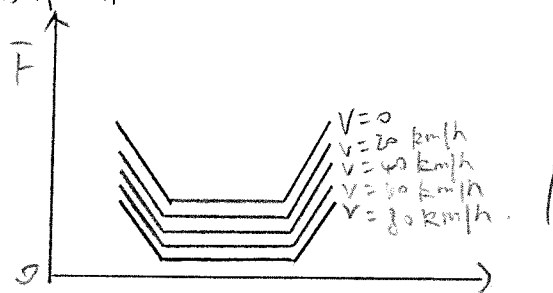
Marks 4

Question VII Steering Gear Design

1. According to the reverse efficiency (逆效率) of steering gear (转向器), what are three kinds of steering gear? (3 marks)
2. How to design the power assisting characteristics (助力特性) of power steering system (动力转向系统), in order to achieve enough steering portability (轻便性) at low speed and good road feeling (路感) at high speed? (9 marks)

1- 答:

2. 答: 在汽车行驶过程中, 使驾驶员更省力地进行转向, 同时不失去对路面的感知, 这种特性称为动力转向系统的助力特性; 为达到这个目的, 汽车低速行驶时, 助力系统应给予更大的助力, 汽车高速行驶时, 为避免导致过多的转向和保持驾驶员轻快的路感, 助力应该小一点



Marks 6

Question VIII Brake Design

1. What are the advantages and disadvantages of disc brakes compared to drum brakes? (6 marks)
2. What is the brake efficiency factor (制动器效能因数)? Please compare the brake efficiency factor and its stability of disc brakes and drum brakes. (6 marks)

解: 1. 相比于鼓式制动器, 盘式制动器的优缺点如下:

- 优点:
- ①: 进水后恢复能力强;
 - ②: 结构简单明了, 占用空间小;
 - ③: 不会产生过大的噪音;
 - ④: 易于维修;
 - ⑤: 可以自由调节摩擦片之间的间隙;
 - ⑥: 使用寿命长。

- 缺点:
- ①: 制造精度要求较高, 成本较高;
 - ②: 不适合用于重型卡车;
 - ③: 需要经常更换摩擦片。
- 检查。