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学院 School	国教

Test Paper of Wuhan University of Technology (A)

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Time: 120mins, class hours, credits, Total Points: 100, Percent in final evaluation

result: %, Date:

No.	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
Full score	23	28	26	23							100
Score	23	26	26	17							92

Score 23

QUESTION I (23 Points)

1. What is the production process of automobiles? What is the manufacturing process of automobile production? (4 points)

汽车的生产过程是将原材料转化成汽车产品的过程。
 工艺过程是通过改变材料的尺寸、形状和性质等使其转变为成品或半成品的过程。

2. What are the three types of auto parts production? (3 points)

汽车零部件的生产类型有：大量生产、成批生产和单件生产。

3. Briefly introduce the methods for obtaining workpiece dimension. (4 points)

工件尺寸的获得方法有：试切法、静调整法、定尺寸刀具法和主动测量法。

4. What is operation? Describe the arrangement principles of machining operation (6 points)

工序是指同一个(组)工人在同一工作地对同一个或几个零件所连续完成的那部分工艺过程。

机械加工工序的安排原则：先粗后精、先主后次、先面后孔、基面先行。

5. What is machining allowance? What are the main factors influencing machining allowance? (6 points)

加工余量是为保证加工质量, 需要在加工表面切除的金属层的厚度。

影响加工余量的因素：①上-工序尺寸公差 ②上-工序加工后留下的表面粗糙度和表面缺陷层的厚度 ③工件各表面相对位置间的空间偏差 ④本工序的装夹误差。

Score 26

QUESTION II (28 Points)

6. Figure 1 shows the positioning condition of transmission case 1. The positioning element consists of two taper pins 2 both movable from top to bottom and from left to right, bearing plate 3 and bearing nail 4. Please analyze (12 points):

(1) What is the over-positioning?

(2) The degree to which the freedom is restricted by the positioning elements in the figure.

(3) Decide whether there exists over-positioning.

(1) 过定位是指定位元件对同一个或几个自由度进行了重复定位的现象。

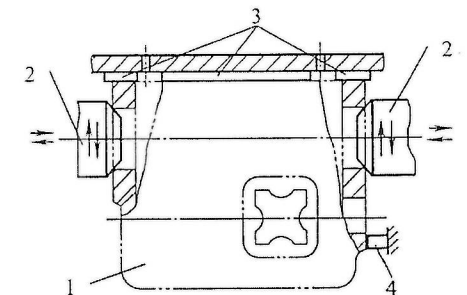
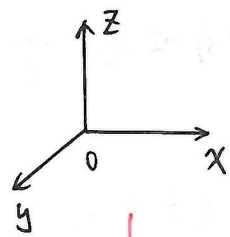


Figure 1

(2) 建立如下坐标系:



支承板3限制:



活动锥销2限制:



支承钉4限制:



一共限制: 6个自由度

(3) 该工件被限制6个自由度, 未出现重复定位, 故不存在过定位现象

7. Figure 2 is a machining and positioning diagram of piston and pin hole. The piston has a full height of $106_{-0.1}^0$ mm, pin hole position of 56 ± 0.08 mm and symmetry requirement of 0.2 mm. Please analyze (16 points):

(1) What is positioning error? What are the main reasons for positioning error?

(2) Please calculate the positioning error of process size 56 ± 0.08 mm.

(3) Assuming that the coaxiality error between the seam allowance and the piston skirt is zero, please calculate the positioning error of the symmetry and determine whether it meets the processing requirement.

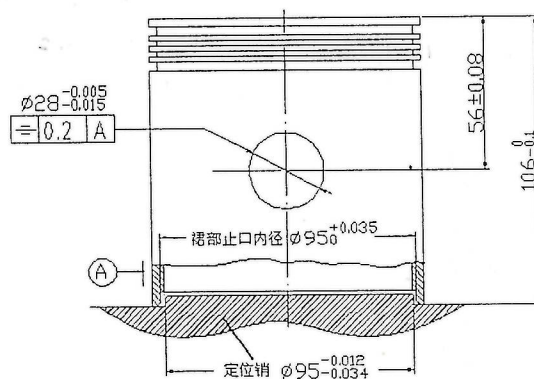


Figure 2

裙部止口内径	Inner diameter of seam allowance on the skirt
定位销	Locating pin

(1) 定位误差是由于定位不准确造成工序基准偏离理想位置, 引起工序尺寸变化造成的加工误差。

定位误差产生的原因有两点: ① 工序基准与定位基准不重合造成基准不重合误差。② 由于定位副制造误差导致定位基准在工序尺寸方向上发生位置变化造成基准位移误差。

$$(2) \Delta d = \Delta j_b + \Delta j_y$$

$$\Delta j_b = 0 - (-0.1) = 0.1 \text{ mm}$$

$$\Delta j_y = 0 \Rightarrow \Delta d = 0.1 \text{ mm}$$

$$(3) \Delta j_b = 0$$

$$\Delta j_y = +0.035 - (-0.034) = 0.069 \text{ mm}$$

$$\Delta d = \Delta j_b + \Delta j_y = 0.069 \text{ mm} > \frac{1}{3} \times 0.2 \text{ mm} = 0.067 \text{ mm}$$

$\Rightarrow$ 故不满足加工要求

8. Figure 3 is the assembly diagram of the first principle axis journal of the crankshaft and the bearing pedestal. 1 is the crankshaft, 2 and 4 are thrust washers, 3 is the mainshaft bearing of the cylinder and 5 is the timing gear. Design requirements: the assembly gap between the journal and shoulder of the first principle axis and the thrust washer is $A_0 = 0.05 \sim 0.25\text{mm}$. Design requirements: $A_1 = 43.5\text{mm}$; $A_2 = A_4 = 2.5\text{mm}$; $A_3 = 38.5\text{mm}$. The assembly method of complete interchange is to be used, to ensure assembly precision. (20 points)

- (1) Please explain the principle of shortest dimension chain.
- (2) Set up assembly dimension chain and determine increasing and decreasing links with circuit method.
- (3) Solve and calculate the dimensional tolerances and limit deviations of the related parts.

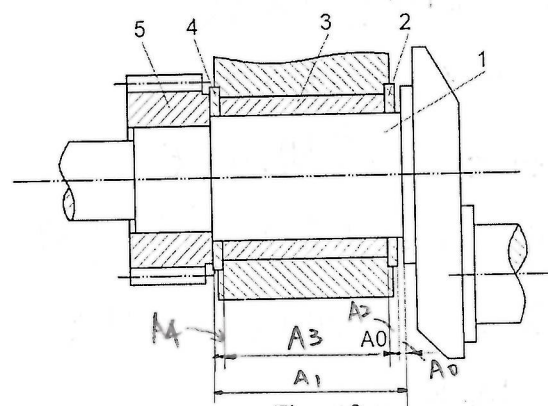
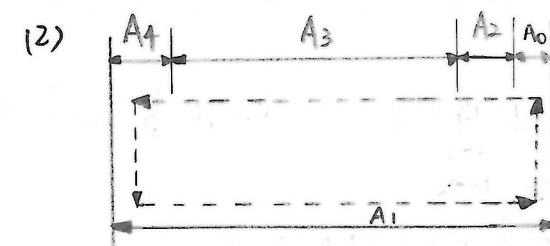


Figure 3

Standard tolerance (from GB/T 1800.3-1998)

Basic dimensions (mm)		≤3	>3~6	>6~10	>10~18	>18~30	>30~50
Tolerance grade (μm)	IT8	14	18	22	27	33	39
	IT9	25	30	36	43	52	62
	IT10	40	48	58	70	84	100

(1) 尺寸链最短原则是指装配尺寸链中组成环数目最少。



由左图可知 A_2, A_3, A_0 为减环, A_1 为增环

$$(3) T_{A_0, Q} = \frac{T_0}{n-1} = \frac{0.25-0.05}{5-1} = 0.05 \text{ mm}$$

选 A_1 为协调环, 取其他组成环公差: $T_{A_2} = T_{A_0} = 0.025 \text{ mm}$

$$T_3 = 0.062 \text{ mm}$$

根据正向体内原则: $A_2 = A_0 = 2.5_{-0.025}^0$, $A_3 = 38.5_{-0.062}^0$
(IT9) (IT9)

$$\text{协调环公差 } T_1 = T_0 - (T_3 + T_2 + T_0) = 0.088 \text{ mm}$$

$$\text{协调环中间偏差 } \Delta_1 = \Delta_0 + \Delta_2 + \Delta_3 + \Delta_0 = +0.094 \text{ mm}$$

$$\Rightarrow ES_1 = \Delta_1 + \frac{T_1}{2} = +0.138 \text{ mm} \Rightarrow A_1 = 43.5_{+0.050}^{+0.138}$$

$$EI_1 = \Delta_1 - \frac{T_1}{2} = +0.050 \text{ mm}$$

故解算结果为: $A_0 = 0_{+0.05}^{+0.25}$, $A_1 = 43.5_{+0.050}^{+0.138}$, $A_2 = A_0 = 2.5_{-0.025}^0$, $A_3 = 38.5_{-0.062}^0$

9. Describe the advantages and disadvantages of the assembly methods of complete interchange and incomplete interchange and the application occasions of such methods. (6 points)

- (1) 完全互换装配法: 优点: ① 装配操作简便, 成本低, 生产率高; ② 具有互换性, 能严格保证装配时间, 利于组织流水生产; ③ 便于将复杂零件于车间之间甚至于工厂之间协作; ④ 利于产品的维修、配件更换;
- 缺点: 当用于装配精度要求高, 组成环数多的场合, 对零件设计公差要求严, 增加了加工难度与成本。

应用场合：组成环数少；或组成环数多，装配精度要求低的情况。

(2) 不完全互换装配法：优点：①将尺寸公差放大到经济公差大小，成本低 ②装配简便，生产率高。

缺点：有极少数零件不满足装配精度要求。

应用场合：大批大量生产中，组成环数多，装配精度要求又高的场合。

Score 17

QUESTION IV (23 Points)

10. As shown in Figure 4, the slender axis workpiece (a and b in Figure 4) and thin-wall cylindric workpiece (c in Figure 4) are cut after being clamped with different fixtures on the machine tool. And different machining errors in dimension and shape occur in the machined parts. Please analyze reasons for the machining errors of the workpieces (6 points)

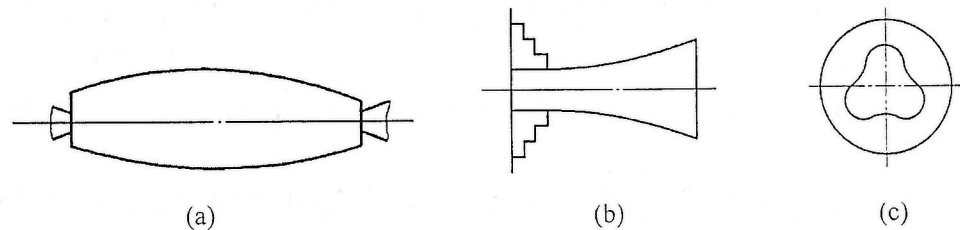


Figure 4

a) 该加工误差是由于工件刚度引起的：如图装夹方式，工作中部刚度最大，故切削量最小；而两边由于变形小，切削量大，故加工成腰鼓形。

b) 该加工误差也由工件刚度引起：此装夹方式使工件类似于悬臂梁，故外伸端变形最大，切削量最小，故形成如图所示喇叭形。

c) 该工件刚开始采用三爪卡盘装夹，形成“三爪形”此形状，打孔后形成“三爪形”此形状，将工件取下后，工作弹性变形恢复后，便形成图中所示形状。

11. Machine separately two batches of workpieces on the machine tool with static adjustment method. The dimension distribution curves obtained are shown as A and B in Figure 5. Δ is the dimension distribution range; ΔL is the deviation of the distribution center of the two batches of workpieces and T is the process tolerance of the workpiece. Please analyze: (11 points)

- (1) What is the 6 σ principle? What does it mean in the manufacturing process?
- (2) Please determine the nature of the machining error leading to the change in the dimension distribution curves of the two batches of workpieces and describe how to eliminate the machining error.
- (3) Please provide the condition for ensuring that there is no rejected part in the two batches of workpieces.

(1) 分布曲线与公差带

的面积代表了一批工件的全部，而在 $\pm 3\sigma$ 范围内的工件数量达到了 99.73%，生产中认为全部工件尺寸都落在该范围，这就是 6 σ 原则。6 σ 代表了一定生产条件

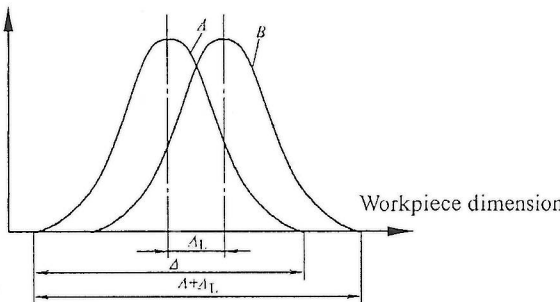


Figure 5

下，一批零件能达到给定的加工精度，一般认为公差若大于 6 σ ，则能满足加工精度要求。

(2) 造成两批工件尺寸分布曲线变化的加工误差属于随机误差，随机误差应通过改变工艺过程或应用合适的加工方法来消除。

(3) 即允许的公差值 $T > \Delta + \Delta L$

12. Analyze the influences of cutting heat on residual stress on the machined surface of the workpiece in the cutting process, at the end of cutting and when the workpiece is completely cooled in the machining process based on Figure 6. Here, t_H representing room temperature when the workpiece has high plasticity and t_p refers to the temperature; $+\sigma$ and $-\sigma$ represent tensile stress and compressive stress, respectively; 1, 2 and 3 represent three layers of metal at different distances from the workpiece surface, respectively. (6 points)

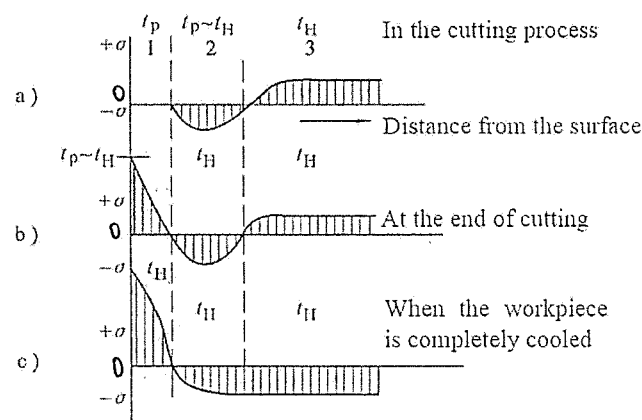


Figure 6

a) 在切削过程中, 工件最外表面温度最高, 但不存在残余应力, 随着离工件表面距离的增大, 工件的温度逐渐降低, 中间部分存在残余压应力, 内部存在残余拉应力。

b) 切削完毕后, 除工件表面温度介于室温与高温之间, 中部与内部均降至室温, 此时, 外表面与最内层存在残余拉应力, 中部存在残余压应力。

c) 工件完全冷却后, 外层残余拉应力, 中部与内层残余压应力。

可分析出: - 开始工件外表面无残余应力可能是工件外表面受热均匀导致的, 而工件中部与内部由于受热不均匀产生残余应力; 而工件冷却时, 外表面也应冷却不均匀产生残余应力。

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