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Test Paper of Wuhan University of Technology (A)

2018~2019 Academic Year 2nd Semester, Course: Manufacturing Technology of Automobile and Engine, Closed-book exam

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	22	19	14	20							75

Score 22

QUESTION I (23 Points)

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

答: 汽车的生产过程是汽车从原材料加工成汽车产品的全过程
工艺过程是生产过程中, 改变生产对象的尺寸、形状、相对位置和性质等, 使之成为成品或半成品的过程

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

答: ① 单件生产
② 大量生产
③ 成批生产

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

答: ① 试切法: 试切-测量-调整-再试切达到加工要求
② 静调整法: 加工前先调整好刀具位置并加工过程中保持其不动
③ 定尺寸刀具法: 如钻孔等
④ 主动及自动测量控制法

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

答: 同一工作地, 对同一工件或几个工件所连接的部分连续完成的那一部分工艺过程叫工序

机械加工工艺的安排原则:

- ① 先加工基准面, 后加工其它表面
- ② 先加工平面, 后加工孔
- ③ 先加工主要表面, 后加工次要表面
- ④ 先粗加工, 后精加工

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

答: 为了保证加工质量, 从加工表面上切除的金属层的厚度叫加工余量

影响加工余量的因素:

- ① 上一工序的尺寸公差
- ② 上一工序留下的表面粗糙度和毛坯缺陷层的深度
- ③ 各加工表面相对位置间的空间偏差
- ④ 本工序的装夹误差

Score 19

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) 过定位是某一自由度被定位元件定位两次或两次以上
(见反面)

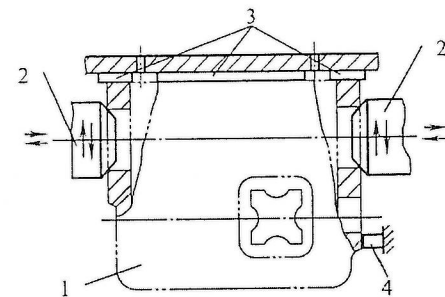


Figure 1

12) 支承板3: 限制 $\bar{z}, \bar{x}, \bar{y}$ 3个自由度

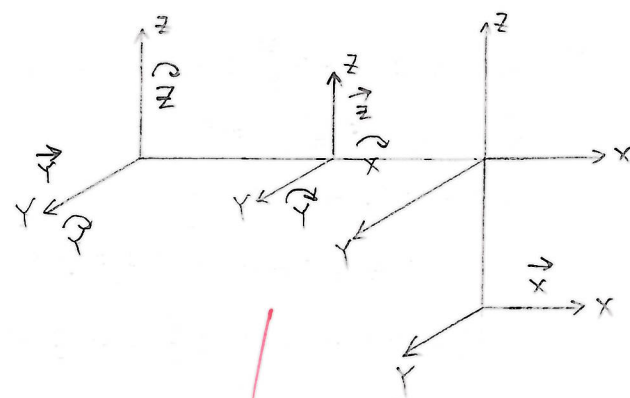
支承钉4: 限制 $\bar{x}$ 1个自由度

2个活动推销2: 限制 $\bar{y}, \bar{z}$ 2个自由度

组合定位共限制 $\bar{x}, \bar{y}, \bar{z}, \bar{x}, \bar{y}, \bar{z}$ 6个自由度

13) $\bar{y}$ 被支承板3和活动推销2限制2次

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.

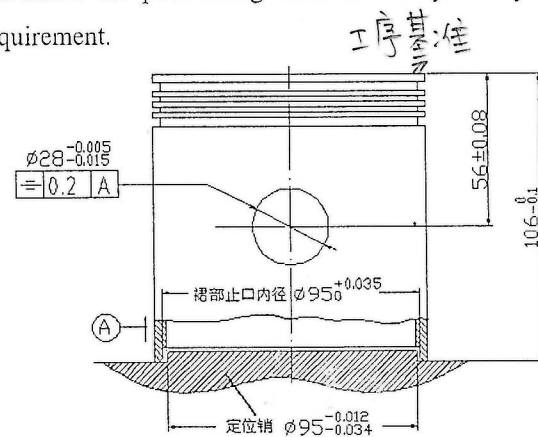


Figure 2

11) 定位误差 Δd 是由于定位不准确, 使工序基准偏离理想位置, 引起工序尺寸变化的加工误差

定位误差产生原因: ① 由于工序基准与定位基准不重合引起的基准不重合误差 $\Delta_{j,b}$

② 由于定位元件制造误差引起的基准位移误差 $\Delta_{j,y}$

12) 工序尺寸 56 ± 0.08 mm 的工序基准为活塞上表面

$$\Delta d = 0.16 + 0.1 = 0.26 \text{ mm}$$

13) 对称度的工序基准为销孔的轴曲线

$$\Delta d = \frac{0.035}{2} = 0.0175$$

$$\Delta d \approx \frac{I}{3} = 0.067 \text{ mm}$$

不满足加工要求

Score 14

QUESTION III (26 Points)

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.

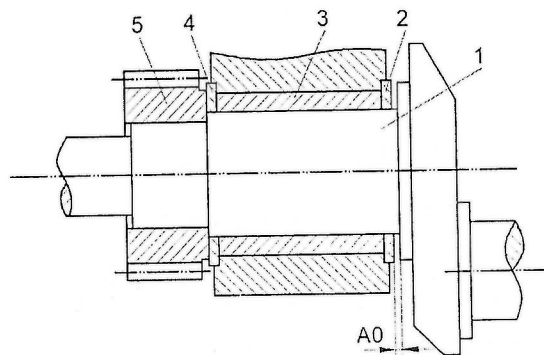
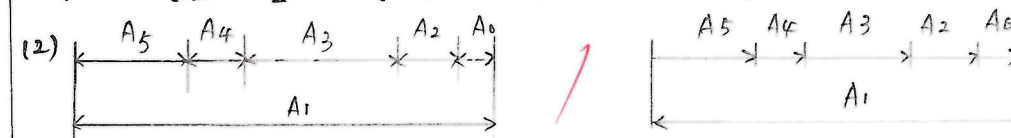


Figure 3

Standard tolerance (from GB/T 1800.3-1998)

Basic dimensions (mm)		≤ 3	$>3 \sim 6$	$>6 \sim 10$	$>10 \sim 18$	$>18 \sim 30$	$>30 \sim 50$
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: 参与组成装配尺寸链的组成环数目最少, 即影响装配精度的零件只能有一个尺寸参与该装配精度建立的装配尺寸链



增环: A_1

减环: A_2, A_3, A_4, A_5

$$(3) A_0 = 0^{+0.25}_{+0.05} \text{ mm}$$

$$T_{A_0, L} = \frac{T_{A_0}}{5} = 0.04 \text{ mm}$$

$$A_0 = A_1 - (A_2 + A_3 + A_4 + A_5)$$

$$A_5 = 0$$

取 A_1 为协调环

$$修正 T_{A_2} = T_{A_4} = 0.025 \text{ mm (IT9)}$$

$$T_{A_3} = 0.062 \text{ mm (IT9)}$$

$$T_{A_5} = 0.025 \text{ mm (IT9)}$$

$$T_{A_1} = T_{A_0} - T_{A_2} - T_{A_3} - T_{A_4} - T_{A_5}$$

$$T_{A_1} = 0.063 \text{ mm}$$

偏差注入体内

$$A_2 = 2.5^{0}_{-0.025} \text{ mm} \quad A_3 = 38.5^{0}_{-0.062} \text{ mm} \quad A_4 = 2.5^{0}_{-0.025} \text{ mm} \quad A_5 = 0^{0}_{-0.025} \text{ mm}$$

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)

答: ① 完全互换装配法: 装配精度取决于零件制造精度, 零件具有互换性, 有利于专业化生产和流水式装配, 生产率高, 但组成环数目较多, 装配精度要求高时, 零件制造公差小, 制造成本提高, 适用于组成环数目较少或组成环数目较多但装配精度要求低的情况。

② 不完全互换装配法: 零件制造公差放大, 制造成本降低, 装配操作简单, 生产率高, 但装配后有极少零件不合格, 适用于大批大量生产中组成环数目较多, 装配精度要求较高的场合。

Score **20**

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)

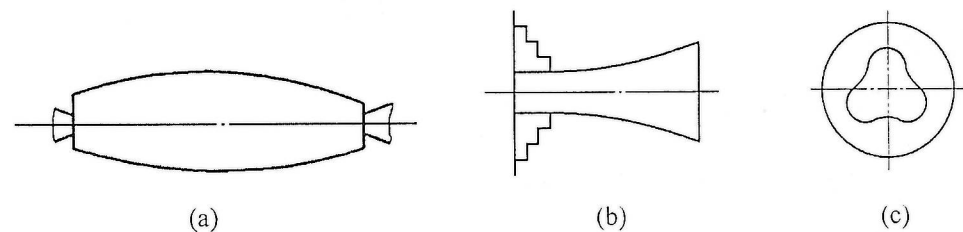


Figure 4

答: (a) 工件采用两顶尖装夹, 在工件中间位置挠度最大, 刚度最小, 切削的金属层薄, 两头刚度大, 切削金属层厚, 零件加工后成腰鼓形

(b) 工件采用三个卡盘装夹, 工件最右端挠度最大, 刚度最小, 切削的金属层最薄, 靠近卡盘处刚度大, 切削金属层厚, 零件加工后呈喇叭口形

(c) 用三个卡盘加工薄壁筒形工件, 由于工件径向刚度差, 夹紧力沿圆周分布也不均匀, 在夹紧力作用下, 工件会发生变形, 加工完孔后去掉夹紧力, 工件恢复原来的形状, 加工的孔就会发生相应变形

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.

11) 6 σ 原则: 认为生产加工中零件所有尺寸均落在 $\bar{x} \pm 3\sigma$ 的尺寸范围内, 6 σ 大小代表了某种加工方法在一定条件下所能达到的精度

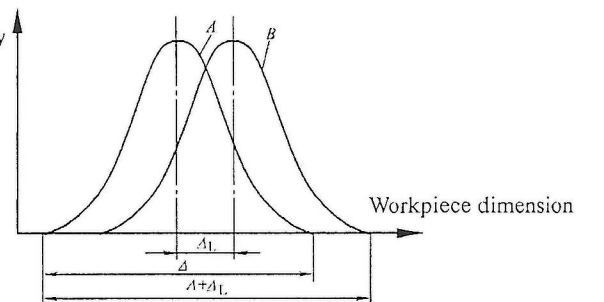


Figure 5

- (2) ① 尺寸分散范围 Δ 是由随机误差造成的, 随机误差越大, 尺寸越分散, 随机误差不能消除, 但可以找到误差产生的原因, 对随机误差进行控制
- ② 两批工件尺寸分散中心的偏移量 ΔL 是由常值系统性误差造成的, 常值系统误差可以在加工时给予一个补偿来消除
- (3) 两批工件均不出废品条件: $T \geq \Delta + \Delta L$

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)

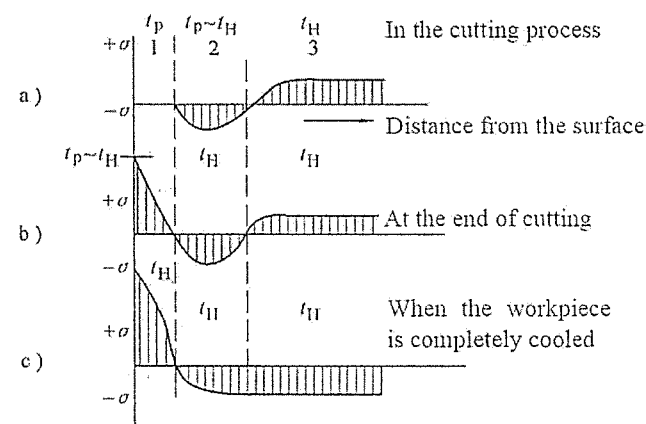


Figure 6

答: ① 切削过程中, 金属层1先受热, 热量向里传递, 金属层2受残余压应力, 金属层3受残余拉应力

② 切削完毕, 表层金属层1受残余拉应力, 金属层2处于热平衡, 仍受残余压应力, 金属层3受残余拉应力

③ 工件完全冷却过程中, 内应力会重新分布, 使表层金属层1受残余拉应力, 内层金属层2、3受残余压应力。