

姓名 Name	李东林
学号 Student ID	0121628250328
专业班级 Class	车辆0103
学院 School	国际教育学院

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	20	26	19	19							84

Score 20

QUESTION I (23 Points)

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

从原材料到汽车产品的全过程叫做汽车的生产过程

在生产过程中, 改变加工对象的尺寸、形状、位置、性质, 使其成为成品或半成品的过程叫做工艺过程

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

单件生产 成批生产 大量生产

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

试切法 静调整法 定尺寸刀具法 主动及自动测量控制法。

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

工序: 有一个或一组工人, 在同一工作地点上, 对一个或几个工件所连续完成的那部分工艺过程。

先基面后其它表面 先平面后加工孔, 先主要表面后次要表面, 先粗加工再精加工。

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

为保证零件加工质量, 在零件表面切掉一层金属层, 这层金属层的厚度就叫做加工余量

零件的尺寸, 零件所要求的加工精度和表面粗糙度, 零件的加工方法,

零件的材料及其物理力学性能, 零件所属的生产类型。

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.

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) 同时有两个以上的定位元件对同一个第一类自由度进行限制的现象。

(2) 支承板3限制了 $\vec{z}$ 和 $\vec{y}$

活动锥销限制了 $\vec{y}$ 和 $\vec{z}$

支承钉4限制了 $\vec{x}$

共限制 $\vec{x}, \vec{y}, \vec{z}$ 三个自由度。

(3) 无过定位现象。

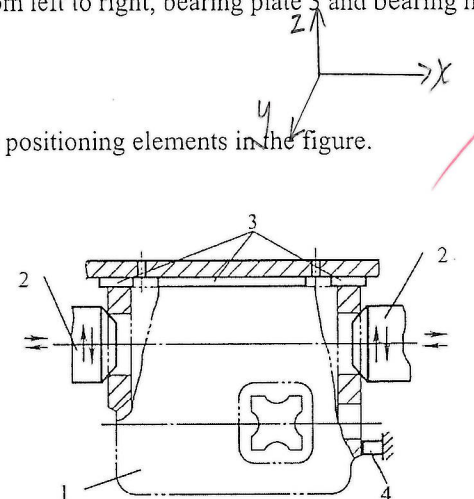


Figure 1

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 0.2mm. 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.

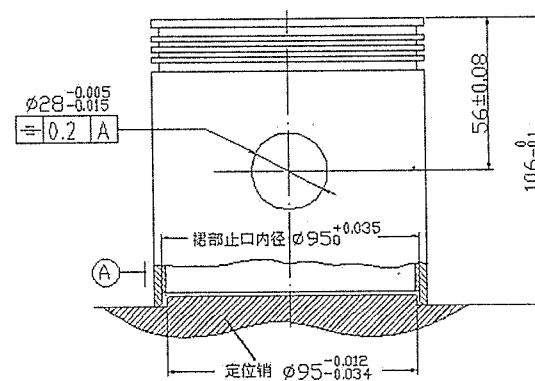


Figure 2

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

(1) 由于定位不准确, 造成工序基准偏离理想位置, 从而使工序尺寸发生变化而产生的误差。

Δj_b 基准不重合误差: 由于定位基准和工序基准不重合所产生的误差。

Δj_y 基准位移误差: 由于定位元件和定位基面的制造误差, 使工序基准在工序尺寸方向上发生偏移而造成的误差。

(2) 定位基准为上表面, 工序基准为下表面, 存在基准不重合误差。

$$\Delta j_b = 0.1 \text{ mm}$$

基准位移误差 $\Delta j_y = 0$

$\therefore$ 定位误差为 0.1 mm

(3) 因为其没有同轴度误差, $\Delta j_b = 0 \text{ mm}$ 。

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

$$\therefore \Delta = 0.069 + 0 = 0.069 \text{ mm} > \frac{0.2}{3} = 0.067 \text{ mm}$$

$\therefore$ 不满足加工要求。

Score 19

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.

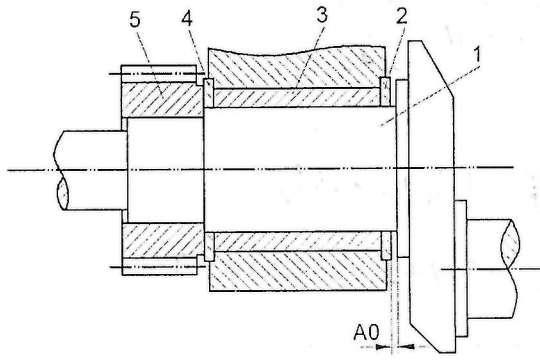
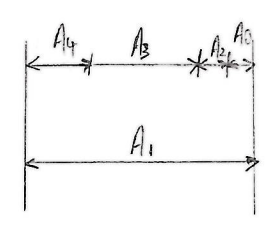


Figure 3
Standard tolerance (from GB/T 1800.3-1998)

Basic dimensions (mm)		≤3	>3~6	>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) 在装配尺寸链中, 组成环的数目需最少。

(2).



增环: A_1
减环: A_2, A_3, A_4
 $A_0 = A_1 - (A_2 + A_3 + A_4)$

设 A_1 为封闭环
(3). $A_0 = A_1 - (A_2 + A_3 + A_4) = 43.5 - (2 \times 2.5 + 38.5) = 0\text{mm}$

$\therefore A_0 = 0_{-0.05}^{0.25}$ $T_{A_0} = 0.25 - 0.05 = 0.2\text{mm}$

$T_{A_1} = \frac{T_{A_0}}{n-1} = \frac{0.2}{5-1} = 0.05\text{mm}$

则取 $T_{A_2} = T_{A_4} = 0.04\text{mm} (IT9)$

$T_{A_3} = 0.039\text{mm} (IT8)$

则按“偏差注入体内原则”取 $A_2 = A_4 = 2.5_{-0.04}^0$ $A_3 = 38.5_{-0.039}^0$

$ES_{A_1} = ES_{A_0} + ES_{A_2} + ES_{A_3} + ES_{A_4} = 0.25$

$ES_{A_1} = ES_{A_0} + ES_{A_2} + ES_{A_3} + ES_{A_4} = 0.25 + [2 \times (-0.04)] - 0.039 = 0.131\text{mm}$

$EL_{A_1} = EL_{A_0} + EL_{A_2} + EL_{A_3} + EL_{A_4} = 0.05 + 0 = 0.05\text{mm}$

$\therefore A_1 = 43.5_{0.05}^{0.131}\text{mm}$

$T_{A_1} = 0.081\text{mm} > IT9$ 满足要求

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)

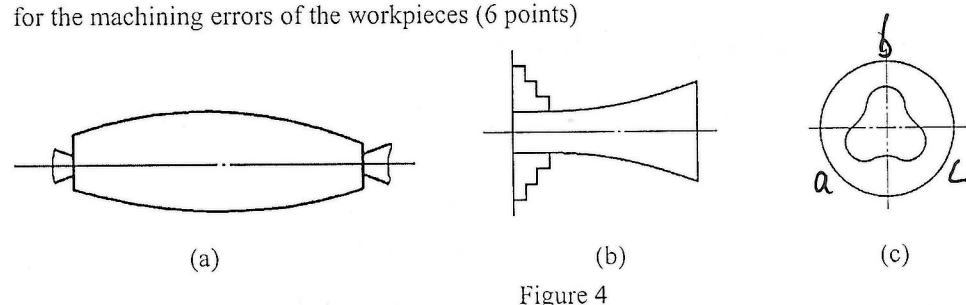
完全互换装配法: 零件之间完全具有互换性, 生产率高, 有利于不同生产厂之间的协作和不同工厂之间的协同生产, 零件不需调整装配后就能满足工艺要求, 后期维修方便。
但由于需要完全互换导致零件公差要求严格, 对机床, 工艺设备及工人的要求较高, 经济性可能较差。
适用于公差要求较严组成环数目较少或组成环数目较多但公差要求较大的零件。

不完全互换装配法：零件公差要求比完全互换装配法低，生产率较高，但仍需正常装配不需调整，但有时会产生不合格产品，不合格产品可通过后期检测筛出，经济性较好，对机床设备要求降低，适用于成批或大量生产几种汽车产品。

Score 19

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)



(a): 由于轴细长，导致轴的中间位置刚度较低，在相同切削力的作用下变形量较大，使得实际切削量较低，加工后形成腰鼓形。

(b): 光轴在卡盘中装夹，与简支梁类似，在离卡盘距离较远的位置，刚度较低，在相同切削力作用下远端变形更严重，破坏了刀具与工件的相对距离使切削量变小，加工后形成喇叭状。

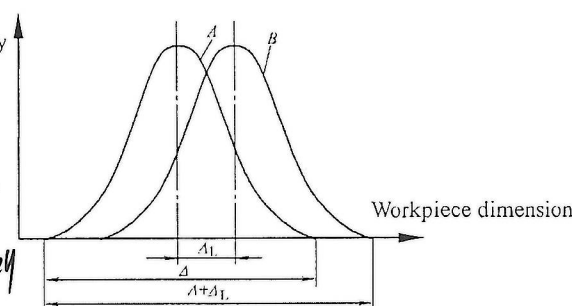
(c): 该工件在三爪卡盘上 a, b, c 装夹，由于壁厚较小，使得 a, b, c 装夹处受力变形严重，向内凹，加工时被切掉的金属较多，虽加工完成后内壁呈圆形，但松开卡盘后，由于弹性变形恢复，形成图示形状。

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) 当一批工件的尺寸呈正态分布

时，其分布曲线与横轴所围的面积代表了这批工件的全部，其中 $\pm 3\sigma$ 的范围占了 99.73%，在生产上常认为所有的工件都分布在 $\pm 3\sigma$ 范围内， $\pm 3\sigma$ 也叫“尺寸分散范围”，这是 6 σ 原则。



6 σ 原则反映了某种加工方法在该生产条件下所能达到的加工精度，只要工件公差大于 6 σ ，就能保证加工精度。

(2) 属于系统误差。系统误差是大小或方向不变或呈一定规律变化的误差，在实际生产中，常用点图法等方法统计出系统误差并在工艺系统中做出相应调整以消除误差。

(3) $T > \Delta + \Delta L$

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)

切削过程：在切削过程

中，表层金属被切去。

且由于刀具与金属表面的摩擦产生大量热量，由于

热胀冷缩和温度的传递，使距表面有一定距离的金属

层体积增大，而更远处的金属层体积增加相对缓慢，在弹性变形范围内

阻碍了2处金属的膨胀，因此2处有拉应力，3处有压应力。

切削完毕：在切削完毕后，表层金属温度开始下降，其塑性降低，但仍处于膨胀状态，内层金属为平复其应力分别产生拉应力和压应力。

冷却至室温：由于切削作用破坏了其原有的晶格，原有的晶格被破碎断裂，发生晶格畸变，失去了原有的致密结构，相应的其密度降低，体积增加，从而在表面产生压应力，内部产生拉应力，形成“表面压内拉”。

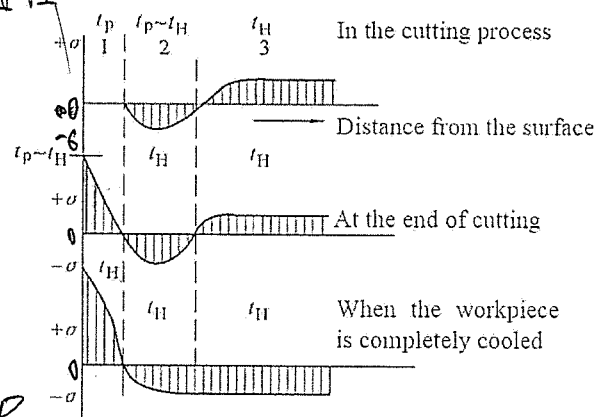


Figure 6

..... BINDING LINE 试卷装订线 装订线内不要答题，不要填写考生信息 试卷装订线
 BINDING LINE No answer or student information within binding edge BINDING LINE