GLASGOW COLLEGE UESTC

Final Main Exam

Engineering Project Management & Finance (UESTC 3031)

Date: 30th May 2022
Time: 19：00-21：00pm

Attempt all PARTS. Total 100 marks

Use one answer sheet for each of the questions in this exam.
Show all work on the answer sheet.
For Multiple Choice Questions, use the dedicated answer sheet provided.

Make sure that your University of Glasgow and UESTC Student Identification Numbers are on all answer sheets.

An electronic calculator may be used provided that it does not allow text storage or display, or graphical display.

All graphs should be clearly labelled and sufficiently large so that all elements are easy to read.

The numbers in square brackets in the right-hand margin indicate the marks allotted to the part of the question against which the mark is shown. These marks are for guidance only.

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Q1 Multiple Choice Questions (MCQs): There are 12 MCQs. You are provided with five options to each question (A, B, C, D, or E). ONLY one of the five is the correct answer for each question.

(1.1) What is a critical path? [2]

A – The longest path through the project network with least amount of slack

B – The shortest path through the project network with maximum amount of slack

C – The shortest path through the project network with least amount of slack

D – The shortest chain of tasks that considers both task dependencies and resource dependencies

E – The longest chain of tasks that considers both task dependencies and resource dependencies

(1.2) Consider the structure of a start-up company run by an entrepreneur. Find the correct pair of true statements. [2]

1 Maximum standardisation and formalisation
2 Few layers: Limited middle-line managerial levels
3 Decentralised and indirect supervision
4 Wide span of control (around the entrepreneur)

A – 1 and 2

B – 3 and 4

C – 2 and 3

D – 2 and 4

E – 1 and 3

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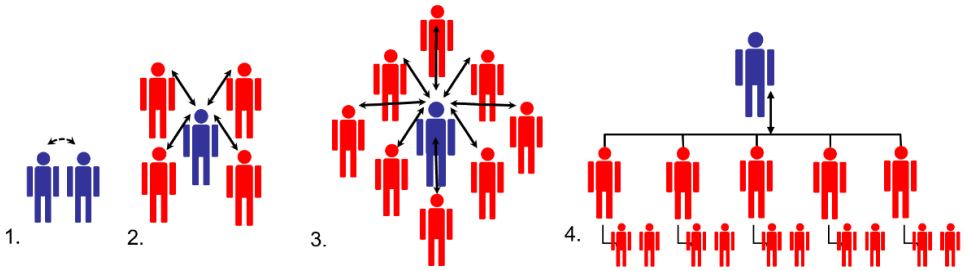
(1.3) The following organisational structures should be labelled as: [2]



A – 1. Start-up; 2. Expansion; 3. Growth; 4. Formal Organisation

B – 1. Expansion; 2. Start-up; 3. Formal Organisation; 4. Growth

C – 1. Start-up; 2. Growth; 3. Expansion; 4. Formal Organisation

D – 1. Expansion; 2. Start-up; 3. Growth; 4. Formal Organisation

E – 1. Growth; 2. Start-up; 3. Formal Organisation; 4. Expansion

(1.4) A project has more than one critical path. What does this mean? [2]

A – Risk increases

B – Risk decreases

C – The duration of the project reduces

D – The project may cost less

E – Nothing happens

(1.5) Which document is created by breaking a project scope into smaller and more manageable elements? [2]

A – Scope baseline

B – Organisational breakdown structure (OBS)

C – Work breakdown structure (WBS)

D – Statement of work (SOW)

E – Budget report

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(1.6) In the execution phase of a project, key resources are lost, and new staff join. The project manager sets up a meeting with the new team. What should be the most important agenda item for this meeting? [2]

A – Discussing team building activities

B – Reviewing WBS and responsibilities of all team members

C – Inviting the team members to share their past project experiences

D – Planning risk responses for existing risks

E – All of the above

(1.7) It costs 1000 RMB for hand tools and 1.50 RMB labour per unit to manufacture a product. An alternative is to manufacture the product with automated machinery costing 15,000 RMB, with a 0.50 RMB per-unit cost. With an annual production rate of 5000 units, how long will it take to reach the production cost cross-over point? [2]

A – 2.0 yr

B – Never

C – 3.6 yr

D – 2.8 yr

E – 0.9 yr

1000 15000 0.5

1.5

$1000 + 1.5 \times 5000 \times Y$

$15000 + 0.5 \times 5000 \times Y$

$15000 + 0.5 \times 5000 \times Y = 1000 + 1.5 \times 5000 \times Y$

(1.8) If a production process follows a normal distribution for the components it produces, the percentage of components falling between +/- 1σ (Standard Deviation) about the mean is: [2]

A – Exactly 50%

B – Approximately 95%

C – Approximately 68%

D – Approximately 34%

E – Approximately 99.7%

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(1.9) In the development of a new product, the impact on Price, Quality, and Manufacturing time is: [2]

A – Product Development: 20-30%, Manufacturing: 70-80%

B – Product Development: 70-80%, Manufacturing: 20-30%

C – Product Development: 50%, Manufacturing: 50%

D – Sales & Marketing: 33.3%, Product Development: 33.3%, Manufacturing: 33.3%

E – Sales & Marketing: 50%, Product Development: 50%

(1.10) You are a quality engineer in an electronic factory making LED headlamps for vehicles. A key indicator of the predicted lifetime of an LED lamp is a measure of its dynamic slope resistance as this gives an indication of the lamp self-heating energy; if the dynamic resistance is low, there less self-heating and hence a longer lifetime. Based on a stable production process, the measurements of the dynamic resistance of the LEDs obey a Gaussian (Normal) distribution with a mean of 25 ohms and a standard deviation of 2.0 ohms. What percentage of the LED production will have dynamic resistance greater than the upper specification limit of 30 ohms? [2]

A. 47.725%

B. 1.241%

C. 0.62%

D. 16.67%

E. 2.5%

$\mu = 25\,\Omega$.

$\sigma = 2\,\Omega$.

$25 + 2.5 \times 2$

$A = 2.5$

(1.11) Analysing the data from the LEDs production process defined in Q1.3 in more detail you decide to calculate the *Cpk* for the process. If the Upper Specification limit *(USL)* is 30 ohms, and the Lower Specification Limit *(LSL)* is 18 ohms, what is the correct *Cpk* for this process? [2]

A. Cpk = 1.0

B. Cpk = 2.0

C. Cpk = 4.58

D. Cpk = 1.167

E. Cpk = 0.833

30 25 18

$\frac{5}{6}$ 7

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(1.12) The three variables of the project planning process: [2]

A – Cost, Time, Performance

B – Price, Delivery, Quality

C – Power, Speed, Cost

D – Slack Time, Tasks, Resources

E – Manpower, Critical Path, Temperature

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Q2 As a young entrepreneur you would like to guarantee a healthy total cost of ownership via evaluating net present value of your young company while utilising discounted cash flow analysis.

(a) Consider your company is designing a new product that will take your company three years to design, fabricate, and build. For this product, your company's expenses are 1,000,000 RMB per year, which will increase with inflation rate of 5% annually. How much must your company quote your customer (for delivery in three years time) if your company would like to cover their expenses and earn a net profit (in today's equivalent currency) of 100,000 RMB. [3]

(b) Consider your company would like to purchase a new machine that has a purchase price of 10 Million (M) RMB with a lifetime of five years. The machine will require annual maintenance costs of 1 M RMB associated with annual power costs of 0.5 M RMB. All costs are fixed with inflation of 10% applied to power only.

(i) Demonstrate the total projected costs over the lifetime of this new machine. [3]

(ii) Analyse the total cost of ownership over the lifetime of this new machine. [4]

(c) Consider you have decided that your company will make a significant investment into expanding its presence in China by setting up a large assembly facility in Chengdu. Your company has estimated its initial set up costs to be in the region of 6,398 M RMB. Net income from this new assembly facility is forecasted as follows:

Year (Y) 1: 1,400 M RMB
Y2: 1,450 M RMB
Y3: 1,550 M RMB
Y4: 1,625 M RMB
Y5: 1,480 M RMB

(i) Calculate the projected payback time for this new assembly facility to the nearest month. [5]

(ii) Calculate the net present value of this new assembly facility based on a discounting factor of 5%. [7]

(iii) Comment on the attractiveness of this new assembly facility. [3]

Q.3 You are a design engineer of high-quality audio products for recording and replaying music within recording studios. This equipment must deliver the best quality sound to the musicians and recording engineers demanding the use of high-quality components. One such component is the high precision voltage reference device used by both the Analog to Digital Converter (ADC) and Digital to Analog Converter (DAC) converters.

As part of the production process, you must select and calibrate the voltage reference devices before installing into equipment. You do this by randomly selecting a sample of 50 parts from a standard batch size of 1000 parts supplied by the manufacturer, measuring the voltage output of the devices using a precision laboratory voltmeter. You then plot the results on a capability chart. The results for the latest batch delivered to your facility are plotted in Figure 3a.

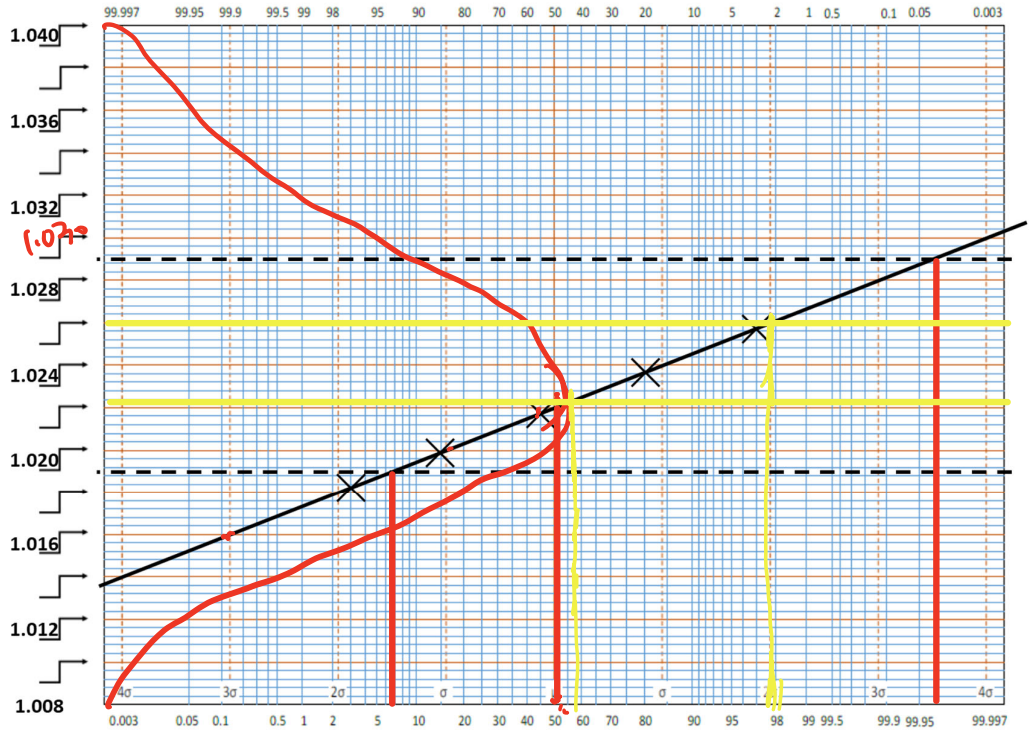

Figure 3a

(a) From the data plotted on the graph shown in Figure 3a, determine the mean and +/- 3 standard deviation points for the data. Please give your answers accurate to 3 decimal places. [6]

(b) The diagram also shows the USL and LSL for production. Write down the values for the USL and the LSL, and the proportion of product from this batch that fall outside these production limits. Hence, calculate how many parts from this batch are acceptable by production. [3]

(c) Using the values of USL and LSL given in part (b), calculate the Cpk for this production run giving your answer to 3 decimal places. Referring to the Cpk value you calculate, determine whether this process is Centered and Capable, Centred and

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$C_{pk} = \frac{1.022 - 1.019}{3\sigma} = \frac{0.003}{3 \times 0.002} = 0.5$

$C_{pk} > 1$ $C_{pk} = 1$ $C_{pk} < 1$

capable 中心刚好3σ 不capable. ⇒ 不center不capable.

not Capable, or not Centered and not Capable. Write a short paragraph referring to the graph and explaining your decision. [6]

(d) A new customer is found for your products but requires a tighter tolerance than you presently manufacture. The new customer specification for the precision voltage reference is 1.024V +/- 2mV. Using the data in figure 3a and applying the new, tighter tolerance of 1.024V +/- 2mV, how many high quality products can you manufacture from the batch shown in figure 3a if each piece of equipment requires 1 precision reference? [3]

1.022 / 1.026

(e) Your sales manager has come up with a 'brilliant' new idea and has asked you to compare the results from this batch of precision references with historical data collected over many previous batches as they want to maximise production (and hence sales revenue). You discover that this batch has a lower mean figure than all previous batches; the long term mean for production has been 1.0240 Volts.

If the spread of the batches are all similar to figure 3a(but the mean is 1.0240V), how many 'super' quality (+/- 1mV), high quality (+/- 2mV), and standard quality (+/- 5mV) products could be manufactured from a batch size of 1000 references with a mean of 1.024V? If 'super quality' units sell for 3000CNY, high quality' units sell for 2000CNY, and standard quality units sell for 1500CNY, What is the maximum revenue that could be generated from a batch of 1000 precision references? Explain your calculations. [7]

$\mu = 1.024$

$\sigma = 0.002$.

$1.024 + A\sigma$ ⇒ 5 $0.002 \times A = 0.001$

$A\sigma = 0.002$ $A = 0.5$

$1.024 + A\sigma$ ⇒ 10 $A = 1$

$A = 5$.

$0.002 = 0.002$

0.5σ $0.19146 \times 2 = 0.38292$. 383

1σ $0.34134 \times 2 = 0.68268$ $683 - 383 = 300$

2.5σ. $0.49379 \times 2 = 0.98758$. $989 - 683 = 306$

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$Q \cdot v + f = s \cdot Q$.

$\Rightarrow Q = \frac{f}{v-s}$

Q4

(a) Derive the theoretical break-even point relationship in terms of fixed costs, variable costs, and selling price. [3]

You work for ABC manufacturing company that supplies the industry with Wi-Fi routers. The company has an annual production capacity of 45,000 routers. Your production cost breakdown for 45,000 routers is shown in Table Q4 below.

Table Q4: Cost breakdown for 45,000 routers

Cost category	Annual Cost (RMB)	per unit cost (RMB)
Direct Materials	405,000	9
Direct Labour	225,000	5
Variable Overhead	45,000	1
Fixed Overhead Cost	562,500	12.5
Total	**1,237,500**	27.5

An outside supplier has approached your company and offered to supply the Wi-Fi routers to your company for 27.5 RMB each. Your manager has asked you to carry out an analysis of this offer. He advises you that the Fixed Overhead Costs for the production facilities will NOT be avoided if you purchase the routers from this outside supplier as your company has no other use for the vacant production facilities if you purchase from the outside supplier.

(b) Draw a table comparing the cost of making the routers internally on a per router basis with the costs of purchasing the routers from the outside supplier. Do you recommend that your company purchases from the outside supplier? [5]

(c) Your manager now tells you he can rent out the production facilities for 570,000 RMB per year. Given this new information, prepare a new cost table showing the impact of the facilities rental. Does this information change your recommendation whether to purchase from the outside supplier? [5]

(d) Utilising the information provided in **Table Q4**, if your company can sell the Wi-Fi routers for 40.00 RMB each, draw a table showing the production costs and sales revenue of manufacturing and selling router quantities from 10,000 → 30,000 routers in 5000 router increments. [5]

(e) If the factory is running at full capacity of 45,000 routers per year with an assumed price of 40.00 RMB per router, what is the profit made by the company? Also, calculate the safety margin for this scenario. [3]

(f) Draw a Breakeven graph showing Total Cost (**TC**), Variable cost (**VC**), Fixed Cost (**FC**), and Revenue (**REV**) against production quantity (**Q**). Calculate the Breakeven Point and indicate this on the graph. [5]

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University of Glasgow

Table Method Example

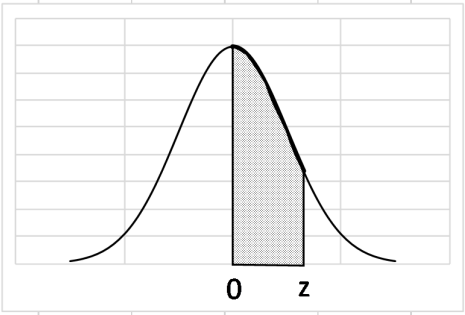
Data for a hamburger stand:

$500 for booth rental per day (fixed costs) 租金费用.
$1 hamburger cost and labor to make the hamburger (variable costs) 可变成本
$2 sales price for hamburger (price) 售价

Qty Sold	Fixed Cost	Variable Cost	Total Cost	Revenue (price X qty)	Profit/Loss
0	$500	$0	$500	0	($500)
100	$500	$100	$600	$200	($400)
200	$500	$200	$700	$400	($300)
300	$500	$300	$800	$600	($200)
400	$500	$400	$900	$800	($100)
500	**$500**	**$500**	**$1000**	**$1000**	**$0**
600	$500	$600	$1100	$1200	$100
700	$500	$700	$1200	$1400	$200

Break-even production is 500 hamburgers per day.

Standard Normal Probabilities



z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.00000	0.00399	0.00798	0.01197	0.01595	0.01994	0.02392	0.02790	0.03188	0.03586
0.1	0.03983	0.04380	0.04776	0.05172	0.05567	0.05962	0.06356	0.06749	0.07142	0.07535
0.2	0.07926	0.08317	0.08706	0.09095	0.09483	0.09871	0.10257	0.10642	0.11026	0.11409
0.3	0.11791	0.12172	0.12552	0.12930	0.13307	0.13683	0.14058	0.14431	0.14803	0.15173
0.4	0.15542	0.15910	0.16276	0.16640	0.17003	0.17364	0.17724	0.18082	0.18439	0.18793
0.5	0.19146	0.19497	0.19847	0.20194	0.20540	0.20884	0.21226	0.21566	0.21904	0.22240
0.6	0.22575	0.22907	0.23237	0.23565	0.23891	0.24215	0.24537	0.24857	0.25175	0.25490
0.7	0.25804	0.26115	0.26424	0.26730	0.27035	0.27337	0.27637	0.27935	0.28230	0.28524
0.8	0.28814	0.29103	0.29389	0.29673	0.29955	0.30234	0.30511	0.30785	0.31057	0.31327
0.9	0.31594	0.31859	0.32121	0.32381	0.32639	0.32894	0.33147	0.33398	0.33646	0.33891
1.0	0.34134	0.34375	0.34614	0.34849	0.35083	0.35314	0.35543	0.35769	0.35993	0.36214
1.1	0.36433	0.36650	0.36864	0.37076	0.37286	0.37493	0.37698	0.37900	0.38100	0.38298
1.2	0.38493	0.38686	0.38877	0.39065	0.39251	0.39435	0.39617	0.39796	0.39973	0.40147
1.3	0.40320	0.40490	0.40658	0.40824	0.40988	0.41149	0.41309	0.41466	0.41621	0.41774
1.4	0.41924	0.42073	0.42220	0.42364	0.42507	0.42647	0.42785	0.42922	0.43056	0.43189
1.5	0.43319	0.43448	0.43574	0.43699	0.43822	0.43943	0.44062	0.44179	0.44295	0.44408
1.6	0.44520	0.44630	0.44738	0.44845	0.44950	0.45053	0.45154	0.45254	0.45352	0.45449
1.7	0.45543	0.45637	0.45728	0.45818	0.45907	0.45994	0.46080	0.46164	0.46246	0.46327
1.8	0.46407	0.46485	0.46562	0.46638	0.46712	0.46784	0.46856	0.46926	0.46995	0.47062
1.9	0.47128	0.47193	0.47257	0.47320	0.47381	0.47441	0.47500	0.47558	0.47615	0.47670
2.0	0.47725	0.47778	0.47831	0.47882	0.47932	0.47982	0.48030	0.48077	0.48124	0.48169
2.1	0.48214	0.48257	0.48300	0.48341	0.48382	0.48422	0.48461	0.48500	0.48537	0.48574
2.2	0.48610	0.48645	0.48679	0.48713	0.48745	0.48778	0.48809	0.48840	0.48870	0.48899
2.3	0.48928	0.48956	0.48983	0.49010	0.49036	0.49061	0.49086	0.49111	0.49134	0.49158
2.4	0.49180	0.49202	0.49224	0.49245	0.49266	0.49286	0.49305	0.49324	0.49343	0.49361
2.5	0.49379	0.49396	0.49413	0.49430	0.49446	0.49461	0.49477	0.49492	0.49506	0.49520
2.6	0.49534	0.49547	0.49560	0.49573	0.49585	0.49598	0.49609	0.49621	0.49632	0.49643
2.7	0.49653	0.49664	0.49674	0.49683	0.49693	0.49702	0.49711	0.49720	0.49728	0.49736
2.8	0.49744	0.49752	0.49760	0.49767	0.49774	0.49781	0.49788	0.49795	0.49801	0.49807
2.9	0.49813	0.49819	0.49825	0.49831	0.49836	0.49841	0.49846	0.49851	0.49856	0.49861
3.0	0.49865	0.49869	0.49874	0.49878	0.49882	0.49886	0.49889	0.49893	0.49896	0.49900
3.1	0.49903	0.49906	0.49910	0.49913	0.49916	0.49918	0.49921	0.49924	0.49926	0.49929
3.2	0.49931	0.49934	0.49936	0.49938	0.49940	0.49942	0.49944	0.49946	0.49948	0.49950
3.3	0.49952	0.49953	0.49955	0.49957	0.49958	0.49960	0.49961	0.49962	0.49964	0.49965
3.4	0.49966	0.49968	0.49969	0.49970	0.49971	0.49972	0.49973	0.49974	0.49975	0.49976
3.5	0.49977	0.49978	0.49978	0.49979	0.49980	0.49981	0.49981	0.49982	0.49983	0.49983
3.6	0.49984	0.49985	0.49985	0.49986	0.49986	0.49987	0.49987	0.49988	0.49988	0.49989
3.7	0.49989	0.49990	0.49990	0.49990	0.49991	0.49991	0.49992	0.49992	0.49992	0.49992
3.8	0.49993	0.49993	0.49993	0.49994	0.49994	0.49994	0.49994	0.49995	0.49995	0.49995
3.9	0.49995	0.49995	0.49996	0.49996	0.49996	0.49996	0.49996	0.49996	0.49997	0.49997
4.0	0.499968328758		Area remaining			*31.67124*				
4.5	0.499996602327		in PPM* beyond 'Z'			*3.397673*				
5.0	0.499999713348					*0.286652*	*or...*	*286.652*	Parts per Billion (10^9)	
5.5	0.499999981010					*0.01899*	*or...*	*18.990*	Parts per Billion (10^9)	
6.0	0.499999999013		* PPM = Parts per Million			*0.000987*	*or...*	*0.987*	Parts per Billion (10^9)	

End of question paper