QUEEN'S UNIVERSITY

FACULTY OF APPLIED SCIENCE

APSC221

SECTIONS 100 (daytime) and 800 (evening)

ECONOMICS AND BUSINESS PRACTICES IN ENGINEERING

FINAL EXAM – December 2011

INSTRUCTORS – Jim M[illegible] Ron Smith

This ex[illegible] final mark

Solution

1. Time available 3 [illegible]
2. Answers to **ALL** questions must be written in the answer booklet that is provided.
3. Use of University-approved, non-programmable, non-communicating calculators will be allowed ONLY.
4. Equation sheets and interest tables are provided at the back of the exam.
5. The exam is out of a total of 50 points. Answer all questions.
6. **PLEASE NOTE: "Proctors are unable to respond to queries about the interpretation of exam questions. Do your best to answer exam questions as written."**
7. **Marks will be deducted** if appropriate interest factors, their designations and appropriate values of interest rate (i) and period (N) are not indicated. You are strongly encouraged to provide cash flow diagrams where appropriate.

Question 1 (5 Marks) – Business Overview, New Business Planning & Project Management

a. The basic management skills required in an organization can be coarsely categorized as being Technical, Human Relations and Conceptual. Match to the diagram below (TAs: I modified this question just before printing the exam and I saved the final version of the exam on the machine at RMC and I don't have it as I write this update; however, the solution below is correct ? **(1 mark)**

1 = Conceptual, 2 = Human Relations, and 3 = Technical

b. For each of the four statements below, clearly indicate if they are **true** or **false**. **(2 marks)**

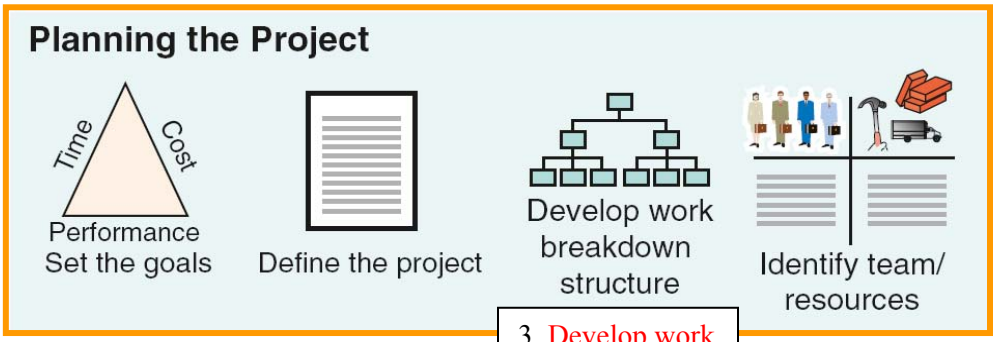
i) A corporation's Board of Directors exists to satisfy government regulation for corporations, and does not make any major corporate decisions. **False, makes major decisions.**

ii) Buying an existing business is generally considered less risky than starting a new one. **True**

iii) A sole proprietorship is a separate legal identity that is registered under the same name as the owner. **False, is not a separate legal identity.**

iv) A corporation must have at least two different shareholders before it can legally pay dividends. **False, a corporation can have a single owner/shareholder and pay dividends.**

c. Project management can be divided into three main sets of activities: Planning, Scheduling and Controlling. Four sub-activities within Planning are depicted, but not labelled in the diagram below. Identify any two of the sub-activities. **(2 marks)**



1. Set goals
2. Define project
3. Develop work breakdown structure
4. Identify team/resources

Question 2 (5 marks) - Risk Management, Change Management & Supplemental Case Study

Recall the solar panel case study. To summarize, a company is investigating the feasibility of opening a manufacturing plant in Canada to produce photovoltaic solar panels. After conducting a preliminary cash flow analysis, the project seems economically viable as long as operating costs can be minimized, and preferably held to as low as 75% of revenue.

For each of the questions below, provide one or two simple sentences or phrases.

a. In an attempt to minimize the risk of escalating operating costs, the company plans to relocate part of their manufacturing facility to a region in Asia. There is not sufficient time to make these arrangements at the start-up of the company. Instead the company will make this change in year 7 as part of the planned upgrade / sustainment activities.

i) Assume that you are put in charge of this relocation project in year 7. In the context of the human element of change management, identify one potential issue that you will have to manage, and briefly describe how you will handle it. **(2 marks –** 1 mark for identifying change, 1 mark for handling it**)**

Any one of the following, or anything reasonable in context re dealing with human reaction to change:

- Relocating personnel – work with staff to pick those who want the opportunity, clear communication, no surprises
- Laying off personnel – communicate plans/rationale well in advance of move, work with staff to find other internal opportunities
- Training new staff – communicate plans well in advance, bring in mentors/.consultants from old facility.

b. Beyond the economic analysis, a preliminary risk assessment was conducted on the overall project. Recall that the following risk categories were used: financial risk, technical risk, commercial risk, execution risk, and contractual / legal risk.

i) Provide an example of a financial or commercial risk to the overall project, and suggest a potential mitigation strategy associated with this risk. You may not use the same risk identified above in part a. **(2 marks** 1 mark for identifying risk, 1 mark for mitigating it**)**

Any one of the following, or anything reasonable in context the solar manufacturing business:

- Large upfront capital investment required, assuming there will be a steady 20-year demand at current prices – Try to sign up distributors for long-term fixed price contracts, or - Seek other financing options in an effort to reduce the weighted cost of capital.
- Subject to variations in interest rates, inflation or Canadian exchange rates – Might mitigate by trying to negotiate all sale & supplier contracts in US$
- Will demand for Solar panel modules remain strong? Current demand is highly motivated by government subsidy programs - Lobby provincial/federal governments and participate in add campaigns to ensure public attention remains on positive renewable energy
- Can the company continue to compete in a growing international market for renewable energy products? - Investigate the option of moving certain manufacturing operations “off-shore” to keep costs competitive.

ii) Explain what is meant by execution risk and provide an example of an execution risk to this overall project. **(1 mark)**

Execution risk refers to the specific unknowns related to the execution (conduct) of the project plan. Examples might include any one of the following (or other reasonable risks in context of actually operating the business):

- Is the management team sufficiently trained / experienced in both manufacturing and photovoltaic technologies?

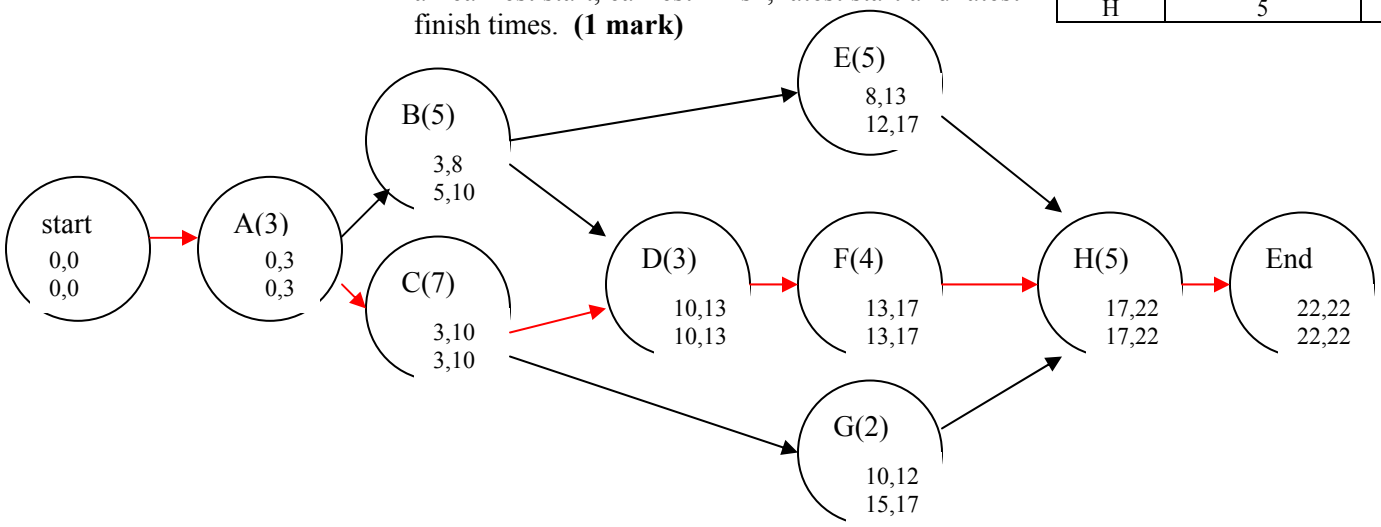
- Is the company capable of withstanding the start-up years where cash flow is significantly negative?

Activity	Duration (weeks)	Predecessors
A	3	-
B	5	A
C	7	A
D	3	B, C
E	5	B
F	4	D
G	2	C
H	5	E, F, G

Question 3 (5 Marks) – Project Scheduling

a. Consider a project with the scheduling information in the table below.

i) Construct an activity-on-node diagram and include all earliest start, earliest finish, latest start and latest finish times. **(1 mark)**



ii) Which tasks are on the critical path and what is the total project duration? **(1 mark)**

A, C, D, F, H for a total duration of 22 weeks

iii) Which task has the largest amount of slack time, and how much? **(1 mark)**

G with a slack of 5 weeks

b. Consider another project. Three of the project activities are candidates for crashing, and all are on the critical path. Details for these activities are provided in the table below.

i) Assuming that no other paths become critical, what action would you take to reduce the critical path by two days? **(1 mark)**

Crash costs: L = $600 / day (max 1 day), M = $900 / day (max 2 days), N = $1,000/day (max 2 days)

Therefore crash activity L for 1 day and activity M for 1 day,

ii) What is the additional cost of this action? **(1 mark)**

for a total additional cost of $1,500.

Activity	Predecessor	Normal Time	Normal Cost	Crash Time	Crash Cost
L	-	7 days	$6,000	6 days	$6,600
M	L	4 days	$1,200	2 days	$3,000
N	M	11 days	$4,000	9 days	$6,000

Question 4 (5 Marks) – Financial Accounting & Capital Budgeting

The table below lists an excerpt of the financial information of a company seeking a business loan.

Financial Item	2009	2010
Total debt	$114,375	$74,875
Total equity	$240,625	$245,125
Current ratio	3.15	2.97
Acid test	1.73	1.65
Return on capital employed	13.7%	14.6%
Return on assets	15.7%	16.0%

a. The tax rate for this company is given as 50%. The average cost of debt has been 12.5% and the average cost of equity has been 10%. The company's WACC for 2009 is 8.8%.

Compute the WACC for 2010. **(1 mark)**

λ_{2010} = debt/(debt+equity) = 74,875/(74875+245,125) = 0.23398 ≈ 23.4%

$WACC_{2010} = \lambda_{2010}(1-t)i_b + (1-\lambda_{2010})e_a$ = (0.234)(0.5)(0.125) + (0.766)(0.1) = 0.09123 ≈ **9.1%**

b. Which type of capital has been more costly for this company on a net basis, debt or equity? Explain. **(1 mark)**

On a net basis, the cost of debt financing has been (0.5)(12.5%) = 6.25% which is less than the cost of equity financing at 10%, therefore **equity capital** has been more costly.

Just look for words/ phrases in bold

c. Comment on the liquidity of this company. Which ratio or ratios support your answer? **(1 mark)**

The **current ratio** and **acid test** are indicators of company liquidity. Both indicate that the company has **sufficient** current (ratio >2) and quick assets (ratio >1) to meet any short term unforeseen requirement. **Healthy**. While these have decreased very slightly, it is not alarming / significant.

d. Comment on the profitability of this company. Which ratio or ratios support your answer? **(1 mark)**

Both the **return on capital employed (ROCE)** and **return on assets (ROA)** are indicators of company profits. Both are rising slightly and both indicate a healthy return, and in particular show that the ROCE > WACC. Profitability is **healthy**.

e. Comment on the overall financial position of this company. If you were the lending institution, would you recommend the loan, why or why not? **(1 mark)**

Overall, the company appears to be healthy based upon the information provided. Justification might be any of the following: **good liquidity**, **good profitability**, and/or **reasonably low ratio of debt to equity**. **Recommend the loan.**

Question 5 (5 Marks) – Comparison Methods

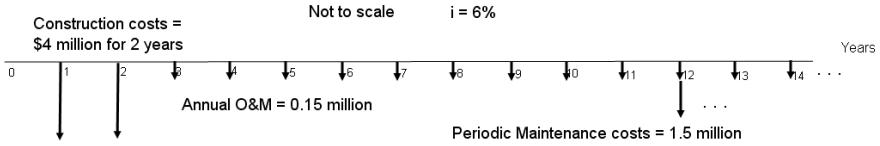
Consider a scenario wherein the Ontario government has to replace the bridge across the Cataraqui causeway in Kingston. Two options are under consideration: a conventional bridge design using steel and concrete construction techniques, and a modern bridge design using fibre reinforced polymer (FRP) composite bridge technology.

Option 1. The bridge using conventional design methods is estimated to cost $8 million and will take two years to design and construct. Assume that these upfront costs are spread evenly across the two years and paid at the end of each year, in other words in years 1 and 2. Annual operating and general maintenance costs are estimated to be $150,000 and will begin after construction, in other words the first costs occur in year 3. Additional periodic maintenance of $1.5 million will be necessary every 10 years after construction; therefore the first one is scheduled in year 12.

Option 2. The bridge using modern design methods is significantly more expensive, estimated to cost $12 million and will take three years to design and construct. Again assume that these upfront costs are spread evenly across the first three years and paid at the end of each year. Annual operating and general maintenance costs are estimated to be much lower at $100,000 and again will begin in the year after construction. Additional periodic maintenance for the modern design is considered to be unnecessary over the life of the bridge.

All costs other than those listed above are assumed to be the same for each option and can therefore be ignored. Assume that each bridge has a significantly long life such that for the purposes of cash flow analysis, they can be considered infinite life. Finally, assume that the province uses an annual interest rate of 6% for cost analysis.

Using a present worth analysis, which bridge option should the province choose?



$PW_{Conventional} = -4(P/A, 6\%,2) – [(0.15 + 1.5(A/F, 6\%, 10)) (P/A, 6\%, \infty)] (P/F, 6\%, 2)$

$= -4(1.8334) - [(0.15 + 1.5(0.0759)) (1/0.06)] (0.8900) = -\$11.247$ million

2 marks

This method treats initial cost as a 2 year annuity, and treats per. maint. as a repeating future amount that can be converted to a repeating annuity.

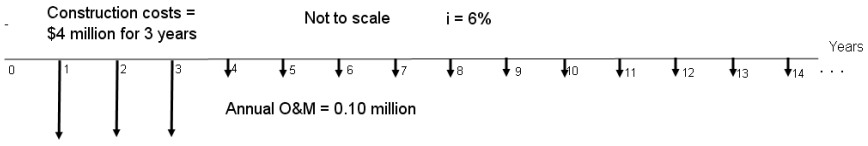
Or

$PW_{Conventional} = -4(P/F, 6\%,1) – 4(P/F, 6\%, 2) – (0.15)(P/A, 6\%, \infty)(P/F, 6\%, 2) – 1.5(P/A, 79.08\%, \infty) (P/F, 6\%, 2)$

$= -4(0.9434) – 4(0.89) – 0.15(1/0.06)(0.89) – 1.5(1/0.7908)(0.89) = -\$11.247$ million

This method treats initial cost as 2 future values, and treats per. maint. as a repeating annuity with a 10 year effective interest rate of $(1.06)^{10}–1= 79.08\%$.

(TAs: During the exam I noticed several of the students interpreted the initial cost as being an annuity; ie $8M present converted to a 2 year annuity of $4,363,495, then brought back to present it becomes $8M again, and $12M present converted to a 3 year annuity of $ $4,489,318, then brought back to present it becomes $12M again . The result is PW_{Conv} = $11,913,046.42 and PW_{modern} = $13,399,365. Do not mark this as wrong.)



$PW_{Modern} = -4(P/A, 6\%,3) – (0.1) (P/A, 6\%, \infty) (P/F, 6\%, 3)$

$= -4(2.6730) – (0.1)(1/0.06)(0.8396) = \$12.091$ million

2 marks

Or

$PW_{Modern} = -4(P/A, 6\%,1) – 4(P/A, 6\%,2) –4(P/A, 6\%,3) – (0.1) (P/A, 6\%, \infty) (P/F, 6\%, 3)$

$= -4(0.9434) – 4(0.89) – 4(0.8396) - (0.1)(1/0.06)(0.8396) = \$12.091$ million

Therefore choose the **conventional design** as it is least cost. 1 mark

Question 6 (5 Marks) – Depreciation & Replacement Analysis

A utility company is buying a new file server for storing smart meter data. The purchase price of the server is $200,000. It has a service life of 4 years, at which point its salvage value is estimated at $20,000. Operating and maintenance costs for the first year are estimated to be $10,000. In each subsequent year the operating and maintenance costs are expected to increase by $2,500. The company wants to know what replacement policy should be adopted.

Assuming straight-line depreciation and a company MARR of 10%, determine the economic life of the server. Make sure that you provide the analysis data for all four years. **(4 marks for the analysis data, 1 mark for identifying the economic life)**

Year	Salvage Value	O&M Costs
0	$200,000	-
1	$155,000	$10,000
2	$110,000	$12,500
3	$65,000	$15,000
4	$20,000	$17,500

$D_{sl} = (P-S)/N = (\$200,000 - \$20,000) / 4 = \$45,000$

$EAC_{(n=1)} = [-200,000 +155,000(P/F, 10\%, 1)] (A/P, 10\%, 1) – 10,000 =$

$= [-200,000 + 155,000(0.9091)] (1.1000) – 10,000 =$ **-$74,998** 1 mark

{or $= -200,000 (A/P, 10\%, 1) + 155,000 – 10,000 = -\$75,000$}

$EAC_{(n=2)} = [-200,000 +110,000(P/F, 10\%, 2)] (A/P, 10\%, 2) – 10,000 – 2,500(A/G, 10\%, 2) =$

$= [-200,000 + 110,000(0.8264)] (0.5762) – 10,000 – 2,500(0.4762) =$ **-$74,052** 1 mark

{or $= [-200,000 + (110,000-2,500)(P/F, 10\%, 2)] (A/P, 10\%, 2)– 10,000 = -\$74,052$}

$EAC_{(n=3)} = [-200,000 +65,000(P/F, 10\%, 3)] (A/P, 10\%, 3) – 10,000 – 2,500(A/G, 10\%, 3) =$

$= [-200,000 +65,000(0.7513)] (0.4021) – 10,000 – 2,500(0.9366) =$ **$73,125** 1 mark

$EAC_{(n=4)} = [-200,000 +20,000(P/F, 10\%, 4)] (A/P, 10\%, 4) – 10,000 – 2,500(A/G, 10\%, 4) =$

$= [-200,000 +20,000(0.6830)] (0.3155) – 10,000 – 2,500(1.3812) =$ **$72,243** ← 1 mark

Therefore the economic life of the server is the same as its service life, **4 years**. 1 mark

Students may also solve this by moving each cash flow back to present individually, then "annualizing" it. For example:

$EAC_{(n=4)} = [-200,000 – 10,000(P/F, 10\%, 1) – 12,500(P/F, 10\%, 2) – 15,000(P/F, 10\%, 3)$

$+ (-17,500+20,000)(P/F, 10\%, 4)] (A/P, 10\%, 4)$

$= [-200,000 – 10,000(0.9091) – 12,500(0.8264) – 15,000(0.7513) + 2,500(0.6830)] (0.3155)$

= **$72,244**

Question 7 (5 Marks) – Taxes

A friend of yours started a small metal engraving business this year. To start the business, an automated engraving machine was purchased for $100,000 on 1 January 2011. This year's projected year-end income before taxes (and before depreciation) is $75,000. Each year thereafter they are expected to increase by $5,000.

The metal engraving machine is a class 43 asset for Canadian taxation purposes, and is therefore allowed to be depreciated at a maximum rate of 30% per year on a declining-balance basis. Your friend's business pays a flat tax rate of 35%.

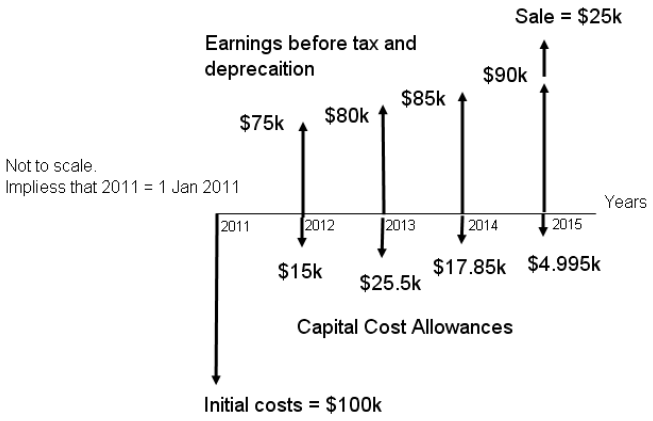
Assume that your friend plans to operate the business for 4 years, at which point they plan to sell the engraving machine for an estimated $25,000 salvage value. For accounting purposes, assume that the sale will take place on 31 December 2014.

a. Compute the estimated capital cost allowance for each of the four years of this business. **(2 marks)**

Year	Adjustments	Opening UCC	CCA	Closing UCC
2011	$100,000	100,000/2 = $50,000	50,000(0.3)= **$15,000**	100,000-15,000= $85,000
2012	none	$85,000	85,000(0.3)= **$25,500**	85,000-25,500= $59,500
2013	none	$59,500	59,500(0.3)= **$17,850**	59,500-17,850= $41,650
2014	-$25,000	$41,650-25,000=$16,650	16,650(0.3)= **$4,995**	16,650-4,995= $11,655

½ mark per year

b. Draw a diagram depicting the "before tax, after depreciation" cash flows for the four years; in other words include the yearly capital cost allowances, but not the yearly taxes. Start your diagram at 1 January 2011 and recall that the end of one year is equivalent to the beginning of another. **(2 marks)**



Or show as resultant cash flows per year:
2011 = -$100k
2012 = $60k
2013 = $54.5k
2014 = $67.15k
2015 = $110.005k

c. Determine the estimated taxes owed in 2013:

i) before (ignoring) depreciation, and **(½ mark)**

Taxes before depreciation owed in 2013:

(2013 **year-end** income before taxes) x (tax rate)

= (85,000) (0.35) = **$29,750**

ii) after depreciation. **(½ mark)**

Taxes after depreciation owed in 2013:

(2013 **year-end** income before taxes- 2013 CCA) x (tax rate)

= (85,000-17,850) (0.35) = **$23,502.50**

Question 8 (5 Marks) – Inflation

A manufacturer of computer peripheral devices is considering adding a line of wireless keyboards. The project would require adding a new manufacturing facility at an initial cost of $22,500,000; assume that this cost occurs immediately. It is estimated that the facility could produce and sell 250,000 keyboards per year. The first keyboards would be available for sale one year from now at a price of $45 in today's (real) dollars. The costs of manufacturing each keyboard are estimated to be $12 in materials and $10 in labour, both in today's dollars.

The study period for this proposal is 6 years, during which time inflation is expected to be 3% per year. The company uses an actual MARR of 15%.

Should the company proceed with this project? Answering yes or no is not sufficient; you must clearly show all of your work.

Net revenue per keyboard = $45 - $12 - $10 = $23 (real$) ½ mark

Net revenue per year = ($23 / keyboard) (250,000 keyboards / year) = $5,750,000 / year (real$) ½ mark

Initial cost = $22,500,000 (real$ or actual$ since it is "now")

Since all future cash flows are in real$, require $MARR_{real}$

$MARR_{real} = (1+MARR_{actual}) / (1+f) - 1 = (1.15) / (1.03) - 1 = 0.1165 = 11.65\%$ 1 mark

Is this project economically viable over a 6 year study period?

Option 1: Determine if PW(at $MARR_{real}$) > 0

1 mark PW = -22,500,000 + 5,750,000 (P/A, 11.65%, 6)

= -22.5m + 5.75m (4.1525)

1 mark ≈ **$1,377,000**

1 mark Therefore **proceed** with the project.

Where :

$(P/A, 11.65\%, 6) = [(1.1165)^6-1]/[(0.1165)(1.1165)^6]$

= 4.1525

Option 2: Set PW = 0 and determine if the IRR_{real} > $MARR_{real}$

0 = -22.5m + 5.75m

$(P/A, IRR_{real}, 6) = 22.5 / 5.75 = 3.913$ or 1 mark

Instead of solving for IRR, test using values of IRR lower and greater than the $MARR_{real}$,

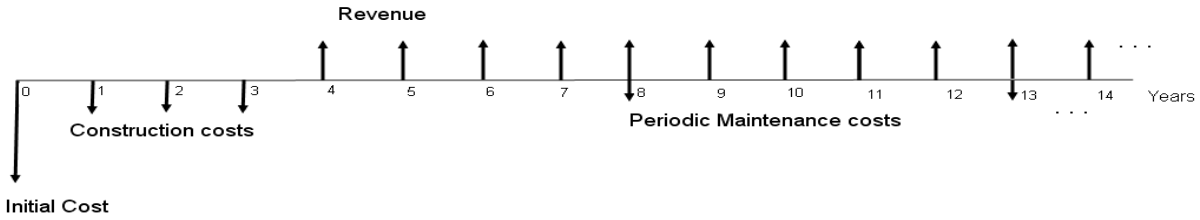
From the tables enclosed, (P/A, 10%, 6) = 4.3553 and (P/A, 12%, 6) = 4.1114

Therefore, we know that **IRR_{real} > 12% > $MARR_{real}$** and we do not need to continue. or 1 mark

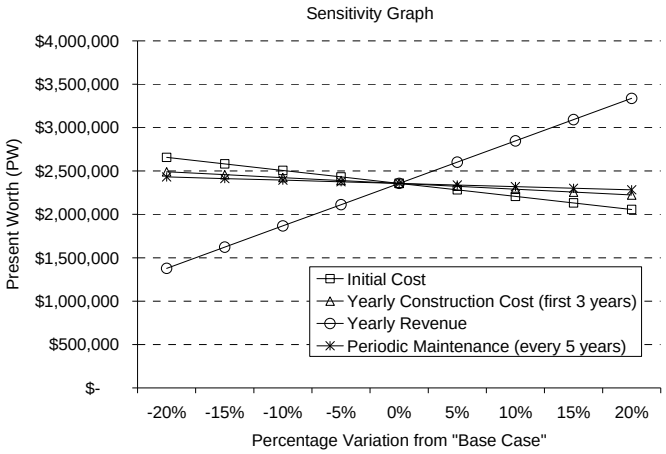
Therefore again the conclusion is to **proceed** with the project. or 1 mark

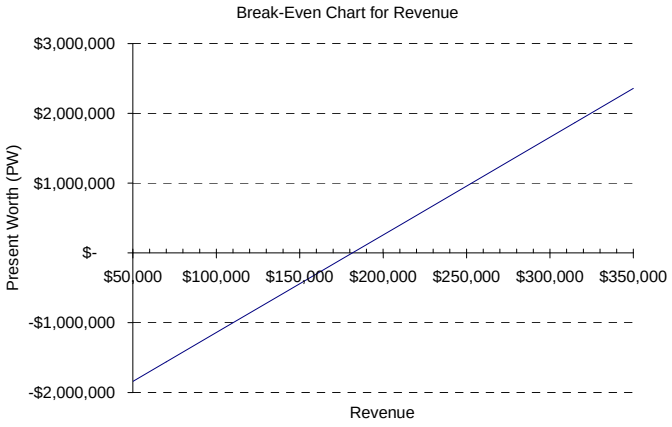
Question 9 (5 Marks) – Sensitivity Analysis

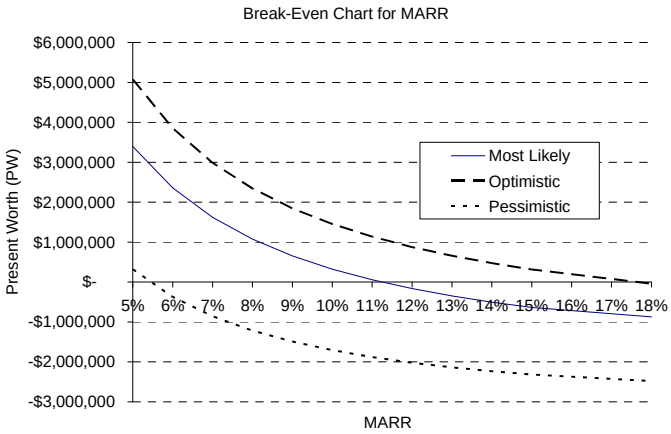
A company is evaluating whether or not to expand its production facility. The major cost parameters are depicted and summarized in the diagram, table and graphs below.



Cost Element	Pessimistic Estimates	Most Likely Estimates	Optimistic Estimates
Initial Cost	$2,500,000	$1,500,000	$900,000
Yearly Construction Cost (Years 1, 2 and 3)	$350,000	$250,000	$200,000
Yearly Revenue (beginning in year 4)	$250,000	$350,000	$400,000
Periodic Maintenance (every 5 years after construction)	$175,000	$150,000	$125,000
MARR	12%	6%	4%
Present Worth	-$ 2,030,234	$ 2,357,163	$ 6,922,030







a. If you were the project manager for the expansion project, which parameter would you be most concerned about controlling? Which one would you be least concerned about? **(1 mark)**

The project is most sensitive to **revenue estimates (most concerned)**

The project is least sensitive to **periodic maintenance (least concerned)**

b. Given the scenarios presented, what is the approximate range of IRRs for this project? **(1 mark)**

IRR ranges from **~5.5%** (pessimistic) to **~17.5 or 18%** (optimistic)

c. Assuming "most likely" estimates for all other parameters, what yearly revenue amount (within $5,000) causes the internal rate of return to be 6%? **(1 mark)**

Use the Revenue break-even graph, where all other parameters are set at the "most likely" values (including MARR=6%). From the graph we see that a revenue amount of **~$180,000** yields a PW = 0; note that this implies that the IRR = MARR = 6%.

d. At a revenue level of $50,000, the project will lose almost $2 million. Is this statement true or false? Justify your answer. **(1 mark)**

This statement is **false**, throughout the course we emphasized that PW is an **equivalence only**. In this case PW = ~$2million means that the series of cash flows (where revenue = $50k) have a present worth equivalent of $2m when discounted at a 6% rate of interest. We can make no statement about the amount of money lost.

e. Missing from this analysis are the impacts of inflation and taxes. If the company's real$, after tax MARR is 11%, should the company proceed with expansion? Explain. **(1 mark)**

Given that the "most likely" scenario IRR is only just greater than 11%, and after factoring in inflation and taxes the IRR would be reduced (perhaps significantly), **then it would <u>not</u> be prudent to proceed**, and certainly not if the company is risk averse, as there is very little likelihood of achieving their MARR.

Question 10 (5 marks) – Risk Analysis

The product design group of Flores Electric Supplies has determined that it needs to design a new series of switches. It must decide on one of three design strategies. The market forecast is for 200,000 switches. The better and more sophisticated the design strategy and the more time spent on value engineering, the less will be the variable costs. The chief of engineering design has decided that the following costs are a good estimate of the initial and variable costs associated with each of the three strategies:

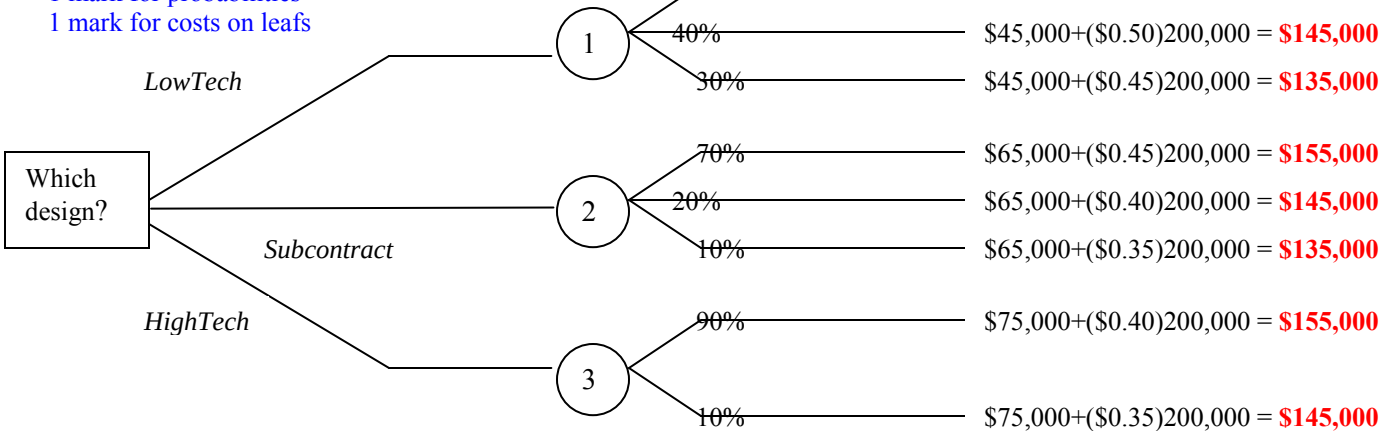
Low-tech: A low-technology, low cost process consisting of hiring a new junior engineer. This option has a fixed cost of $45,000 and variable costs per switch of $0.55 with a probability of 30%, $0.50 with a probability of 40%, and $0.45 with a probability of 30%.

Subcontract: A medium cost approach using a good outside design staff. This option has a fixed cost of $65,000 and variable costs per switch of $0.45 with a probability of 70%, $0.40 with a probability of 20%, and $0.35 with a probability of 10%.

High-tech: A high-technology approach using the very best internal staff and the latest computer-aided design technology. This option has a fixed cost of $75,000 and variable costs per switch of $0.40 with a probability of 90%, and $0.35 with a probability of 10%.

a. Construct a decision tree for this scenario. Include cost estimates at each "leaf" of the tree. **(3 marks)**

1 mark for tree,
1 mark for probabilities
1 mark for costs on leafs



b. Use expected value analysis to determine what option the company should choose. **(2 marks)**

EV(Low Tech) = (0.3)(155,000) + (0.4)(145,000) + (0.3)(135,000) = **$145,000** (½ mark)

EV(Subcontract) = (0.7)(155,000) + (0.2)(145,000) + (0.1)(135,000) = **$151,000** (½ mark)

EV(High Tech) = (0.9)(155,000) + (0.1)(145,000) = **$154,000** (½ mark)

Therefore choose the ***low tech*** **design** as it has the **least cost** expected value. (½ mark)

INTEREST FACTORS

Interest Factor	**Formula**
(F/P, *i*, n)	$(1+i)^n$
(P/F, *i*, n)	$\frac{1}{(1+i)^n}$
(F/A, *i*, n)	$\frac{(1+i)^n-1}{i}$
(A/F, *i*, n)	$\frac{i}{(1+i)^n-1}$
(P/A, *i*, n)	$\frac{(1+i)^n-1}{i(1+i)^n}$
(A/P, *i*, n)	$\frac{i(1+i)^n}{(1+i)^n-1}$
(A/G, *i*, n)	$\frac{1}{i}-\frac{n}{(1+i)^n-1}$
(P/G, *i*, n)	$\frac{(1+i)^n-in-1}{i^2(1+i)^n}$

To calculate effective interest rates:

$$i_e = (1 + r/m)^m - 1$$

$$P = \lim_{N\to\infty} A(P/A, i, N) = A \lim_{N\to\infty}\left[\frac{(1+i)^N - 1}{i(1+i)^N}\right] = \frac{A}{i}$$

Scheduling

$t = (a + 4m + b)/6, \qquad \sigma^2 = [(b - a)/6]^2, \qquad Z=(X-\mu)/\sigma$

Risk Analysis:

Expected value, $E(X) = \sum_i x_i p(x_i)$

Depreciation

$$D_{sl(n)} = \frac{P-S}{N} \qquad BV_{sl(n)} = P - n\left(\frac{P-S}{N}\right)$$

$$D_{db(n)} = BV_{db(n-1)}\ d \qquad BV_{db(n)} = P(1-d)^n$$

Inflation:

$\$Actual = \$Real\ (1+f)^N$

$(1+i) = (1+i')\ (1+f)$

Financial Ratios

Working Capital = current assets - current liabilities

Current ratio = current assets / current liabilities

Acid Test ratio = quick assets / current liabilities

Equity ratio = total equity / (total liabilities + total equity)

Return on Assets (ROA) = net income / total assets

Return on Equity (ROE) = net income / total equity

Inventory Turnover ratio = sales / inventories

Debt to Capital Employed (λ) = debt / (debt + equity)

Return on Capital Employed (ROCE) = EBIT (1-t) / (debt + equity)

Weighted-average Cost of Capital (WACC) = $\lambda\ (1\text{-}t)i_b + (1\text{-}\lambda)e_a$

Where: EBIT is the earnings before interest and tax,

Debt includes all interest bearing liabilities (a portion of liability)

λ is the ratio of total debt (**short and long term**) to total debt plus equity (in other words the debt to capital employed ratio from above),

t is the effective tax rate and can be computed as t = tax paid / earnings before tax

i_b is the cost of debt financing, and

e_a is the cost of equity financing.

i = 6.0%

n	[F/P, i, n]	[P/F, i, n]	[F/A, i, n]	[A/F, i, n]	[P/A, i, n]	[A/P, i, n]	[A/G, i, n]	[P/G, i, n]
1	1.0600	0.9434	1.0000	1.0000	0.9434	1.0600	0.0000	0.0000
2	1.1236	0.8900	2.0600	0.4854	1.8334	0.5454	0.4854	0.8900
3	1.1910	0.8396	3.1836	0.3141	2.6730	0.3741	0.9612	2.5692
4	1.2625	0.7921	4.3746	0.2286	3.4651	0.2886	1.4272	4.9455
5	1.3382	0.7473	5.6371	0.1774	4.2124	0.2374	1.8836	7.9345
6	1.4185	0.7050	6.9753	0.1434	4.9173	0.2034	2.3304	11.4594
7	1.5036	0.6651	8.3938	0.1191	5.5824	0.1791	2.7676	15.4497
8	1.5938	0.6274	9.8975	0.1010	6.2098	0.1610	3.1952	19.8416
9	1.6895	0.5919	11.4913	0.0870	6.8017	0.1470	3.6133	24.5768
10	1.7908	0.5584	13.1808	0.0759	7.3601	0.1359	4.0220	29.6023
11	1.8983	0.5268	14.9716	0.0668	7.8869	0.1268	4.4213	34.8702
12	2.0122	0.4970	16.8699	0.0593	8.3838	0.1193	4.8113	40.3369
13	2.1329	0.4688	18.8821	0.0530	8.8527	0.1130	5.1920	45.9629
14	2.2609	0.4423	21.0151	0.0476	9.2950	0.1076	5.5635	51.7128
15	2.3966	0.4173	23.2760	0.0430	9.7122	0.1030	5.9260	57.5546
16	2.5404	0.3936	25.6725	0.0390	10.1059	0.0990	6.2794	63.4592
17	2.6928	0.3714	28.2129	0.0354	10.4773	0.0954	6.6240	69.4011
18	2.8543	0.3503	30.9057	0.0324	10.8276	0.0924	6.9597	75.3569
19	3.0256	0.3305	33.7600	0.0296	11.1581	0.0896	7.2867	81.3062
20	3.2071	0.3118	36.7856	0.0272	11.4699	0.0872	7.6051	87.2304
21	3.3996	0.2942	39.9927	0.0250	11.7641	0.0850	7.9151	93.1136
22	3.6035	0.2775	43.3923	0.0230	12.0416	0.0830	8.2166	98.9412
23	3.8197	0.2618	46.9958	0.0213	12.3034	0.0813	8.5099	104.7007
24	4.0489	0.2470	50.8156	0.0197	12.5504	0.0797	8.7951	110.3812
25	4.2919	0.2330	54.8645	0.0182	12.7834	0.0782	9.0722	115.9732
26	4.5494	0.2198	59.1564	0.0169	13.0032	0.0769	9.3414	121.4684
27	4.8223	0.2074	63.7058	0.0157	13.2105	0.0757	9.6029	126.8600
28	5.1117	0.1956	68.5281	0.0146	13.4062	0.0746	9.8568	132.1420
29	5.4184	0.1846	73.6398	0.0136	13.5907	0.0736	10.1032	137.3096
30	5.7435	0.1741	79.0582	0.0126	13.7648	0.0726	10.3422	142.3588
31	6.0881	0.1643	84.8017	0.0118	13.9291	0.0718	10.5740	147.2864
32	6.4534	0.1550	90.8898	0.0110	14.0840	0.0710	10.7988	152.0901
33	6.8406	0.1462	97.3432	0.0103	14.2302	0.0703	11.0166	156.7681
34	7.2510	0.1379	104.1838	0.0096	14.3681	0.0696	11.2276	161.3192
35	7.6861	0.1301	111.4348	0.0090	14.4982	0.0690	11.4319	165.7427
36	8.1473	0.1227	119.1209	0.0084	14.6210	0.0684	11.6298	170.0387
37	8.6361	0.1158	127.2681	0.0079	14.7368	0.0679	11.8213	174.2072
38	9.1543	0.1092	135.9042	0.0074	14.8460	0.0674	12.0065	178.2490
39	9.7035	0.1031	145.0585	0.0069	14.9491	0.0669	12.1857	182.1652
40	10.2857	0.0972	154.7620	0.0065	15.0463	0.0665	12.3590	185.9568
41	10.9029	0.0917	165.0477	0.0061	15.1380	0.0661	12.5264	189.6256
42	11.5570	0.0865	175.9505	0.0057	15.2245	0.0657	12.6883	193.1732
43	12.2505	0.0816	187.5076	0.0053	15.3062	0.0653	12.8446	196.6017
44	12.9855	0.0770	199.7580	0.0050	15.3832	0.0650	12.9956	199.9130
45	13.7646	0.0727	212.7435	0.0047	15.4558	0.0647	13.1413	203.1096
46	14.5905	0.0685	226.5081	0.0044	15.5244	0.0644	13.2819	206.1938
47	15.4659	0.0647	241.0986	0.0041	15.5890	0.0641	13.4177	209.1681
48	16.3939	0.0610	256.5645	0.0039	15.6500	0.0639	13.5485	212.0351
49	17.3775	0.0575	272.9584	0.0037	15.7076	0.0637	13.6748	214.7972
50	18.4202	0.0543	290.3359	0.0034	15.7619	0.0634	13.7964	217.4574

i = 10.0%

n	[F/P, i, n]	[P/F, i, n]	[F/A, i, n]	[A/F, i, n]	[P/A, i, n]	[A/P, i, n]	[A/G, i, n]	[P/G, i, n]
1	1.1000	0.9091	1.0000	1.0000	0.9091	1.1000	0.0000	0.0000
2	1.2100	0.8264	2.1000	0.4762	1.7355	0.5762	0.4762	0.8264
3	1.3310	0.7513	3.3100	0.3021	2.4869	0.4021	0.9366	2.3291
4	1.4641	0.6830	4.6410	0.2155	3.1699	0.3155	1.3812	4.3781
5	1.6105	0.6209	6.1051	0.1638	3.7908	0.2638	1.8101	6.8618
6	1.7716	0.5645	7.7156	0.1296	4.3553	0.2296	2.2236	9.6842
7	1.9487	0.5132	9.4872	0.1054	4.8684	0.2054	2.6216	12.7631
8	2.1436	0.4665	11.4359	0.0874	5.3349	0.1874	3.0045	16.0287
9	2.3579	0.4241	13.5795	0.0736	5.7590	0.1736	3.3724	19.4215
10	2.5937	0.3855	15.9374	0.0627	6.1446	0.1627	3.7255	22.8913
11	2.8531	0.3505	18.5312	0.0540	6.4951	0.1540	4.0641	26.3963
12	3.1384	0.3186	21.3843	0.0468	6.8137	0.1468	4.3884	29.9012
13	3.4523	0.2897	24.5227	0.0408	7.1034	0.1408	4.6988	33.3772
14	3.7975	0.2633	27.9750	0.0357	7.3667	0.1357	4.9955	36.8005
15	4.1772	0.2394	31.7725	0.0315	7.6061	0.1315	5.2789	40.1520
16	4.5950	0.2176	35.9497	0.0278	7.8237	0.1278	5.5493	43.4164
17	5.0545	0.1978	40.5447	0.0247	8.0216	0.1247	5.8071	46.5819
18	5.5599	0.1799	45.5992	0.0219	8.2014	0.1219	6.0526	49.6395
19	6.1159	0.1635	51.1591	0.0195	8.3649	0.1195	6.2861	52.5827
20	6.7275	0.1486	57.2750	0.0175	8.5136	0.1175	6.5081	55.4069
21	7.4002	0.1351	64.0025	0.0156	8.6487	0.1156	6.7189	58.1095
22	8.1403	0.1228	71.4027	0.0140	8.7715	0.1140	6.9189	60.6893
23	8.9543	0.1117	79.5430	0.0126	8.8832	0.1126	7.1085	63.1462
24	9.8497	0.1015	88.4973	0.0113	8.9847	0.1113	7.2881	65.4813
25	10.8347	0.0923	98.3471	0.0102	9.0770	0.1102	7.4580	67.6964
26	11.9182	0.0839	109.1818	0.0092	9.1609	0.1092	7.6186	69.7940
27	13.1100	0.0763	121.0999	0.0083	9.2372	0.1083	7.7704	71.7773
28	14.4210	0.0693	134.2099	0.0075	9.3066	0.1075	7.9137	73.6495
29	15.8631	0.0630	148.6309	0.0067	9.3696	0.1067	8.0489	75.4146
30	17.4494	0.0573	164.4940	0.0061	9.4269	0.1061	8.1762	77.0766
31	19.1943	0.0521	181.9434	0.0055	9.4790	0.1055	8.2962	78.6395
32	21.1138	0.0474	201.1378	0.0050	9.5264	0.1050	8.4091	80.1078
33	23.2252	0.0431	222.2515	0.0045	9.5694	0.1045	8.5152	81.4856
34	25.5477	0.0391	245.4767	0.0041	9.6086	0.1041	8.6149	82.7773
35	28.1024	0.0356	271.0244	0.0037	9.6442	0.1037	8.7086	83.9872
36	30.9127	0.0323	299.1268	0.0033	9.6765	0.1033	8.7965	85.1194
37	34.0039	0.0294	330.0395	0.0030	9.7059	0.1030	8.8789	86.1781
38	37.4043	0.0267	364.0434	0.0027	9.7327	0.1027	8.9562	87.1673
39	41.1448	0.0243	401.4478	0.0025	9.7570	0.1025	9.0285	88.0908
40	45.2593	0.0221	442.5926	0.0023	9.7791	0.1023	9.0962	88.9525
41	49.7852	0.0201	487.8518	0.0020	9.7991	0.1020	9.1596	89.7560
42	54.7637	0.0183	537.6370	0.0019	9.8174	0.1019	9.2188	90.5047
43	60.2401	0.0166	592.4007	0.0017	9.8340	0.1017	9.2741	91.2019
44	66.2641	0.0151	652.6408	0.0015	9.8491	0.1015	9.3258	91.8508
45	72.8905	0.0137	718.9048	0.0014	9.8628	0.1014	9.3740	92.4544
46	80.1795	0.0125	791.7953	0.0013	9.8753	0.1013	9.4190	93.0157
47	88.1975	0.0113	871.9749	0.0011	9.8866	0.1011	9.4610	93.5372
48	97.0172	0.0103	960.1723	0.0010	9.8969	0.1010	9.5001	94.0217
49	106.7190	0.0094	1057.1896	0.0009	9.9063	0.1009	9.5365	94.4715
50	117.3909	0.0085	1163.9085	0.0009	9.9148	0.1009	9.5704	94.8889

			i =	12.00%				
n	[F/P, i, n]	[P/F, i, n]	[F/A, i, n]	[A/F, i, n]	[P/A, i, n]	[A/P, i, n]	[A/G, i, n]	[P/G, i, n]
1	1.1200	0.8929	1.0000	1.0000	0.8929	1.1200	0.0000	0.0000
2	1.2544	0.7972	2.1200	0.4717	1.6901	0.5917	0.4717	0.7972
3	1.4049	0.7118	3.3744	0.2963	2.4018	0.4163	0.9246	2.2208
4	1.5735	0.6355	4.7793	0.2092	3.0373	0.3292	1.3589	4.1273
5	1.7623	0.5674	6.3528	0.1574	3.6048	0.2774	1.7746	6.3970
6	1.9738	0.5066	8.1152	0.1232	4.1114	0.2432	2.1720	8.9302
7	2.2107	0.4523	10.0890	0.0991	4.5638	0.2191	2.5515	11.6443
8	2.4760	0.4039	12.2997	0.0813	4.9676	0.2013	2.9131	14.4714
9	2.7731	0.3606	14.7757	0.0677	5.3282	0.1877	3.2574	17.3563
10	3.1058	0.3220	17.5487	0.0570	5.6502	0.1770	3.5847	20.2541
11	3.4785	0.2875	20.6546	0.0484	5.9377	0.1684	3.8953	23.1288
12	3.8960	0.2567	24.1331	0.0414	6.1944	0.1614	4.1897	25.9523
13	4.3635	0.2292	28.0291	0.0357	6.4235	0.1557	4.4683	28.7024
14	4.8871	0.2046	32.3926	0.0309	6.6282	0.1509	4.7317	31.3624
15	5.4736	0.1827	37.2797	0.0268	6.8109	0.1468	4.9803	33.9202
16	6.1304	0.1631	42.7533	0.0234	6.9740	0.1434	5.2147	36.3670
17	6.8660	0.1456	48.8837	0.0205	7.1196	0.1405	5.4353	38.6973
18	7.6900	0.1300	55.7497	0.0179	7.2497	0.1379	5.6427	40.9080
19	8.6128	0.1161	63.4397	0.0158	7.3658	0.1358	5.8375	42.9979
20	9.6463	0.1037	72.0524	0.0139	7.4694	0.1339	6.0202	44.9676
21	10.8038	0.0926	81.6987	0.0122	7.5620	0.1322	6.1913	46.8188
22	12.1003	0.0826	92.5026	0.0108	7.6446	0.1308	6.3514	48.5543
23	13.5523	0.0738	104.6029	0.0096	7.7184	0.1296	6.5010	50.1776
24	15.1786	0.0659	118.1552	0.0085	7.7843	0.1285	6.6406	51.6929
25	17.0001	0.0588	133.3339	0.0075	7.8431	0.1275	6.7708	53.1046
26	19.0401	0.0525	150.3339	0.0067	7.8957	0.1267	6.8921	54.4177
27	21.3249	0.0469	169.3740	0.0059	7.9426	0.1259	7.0049	55.6369
28	23.8839	0.0419	190.6989	0.0052	7.9844	0.1252	7.1098	56.7674
29	26.7499	0.0374	214.5828	0.0047	8.0218	0.1247	7.2071	57.8141
30	29.9599	0.0334	241.3327	0.0041	8.0552	0.1241	7.2974	58.7821
31	33.5551	0.0298	271.2926	0.0037	8.0850	0.1237	7.3811	59.6761
32	37.5817	0.0266	304.8477	0.0033	8.1116	0.1233	7.4586	60.5010
33	42.0915	0.0238	342.4294	0.0029	8.1354	0.1229	7.5302	61.2612
34	47.1425	0.0212	384.5210	0.0026	8.1566	0.1226	7.5965	61.9612
35	52.7996	0.0189	431.6635	0.0023	8.1755	0.1223	7.6577	62.6052
36	59.1356	0.0169	484.4631	0.0021	8.1924	0.1221	7.7141	63.1970
37	66.2318	0.0151	543.5987	0.0018	8.2075	0.1218	7.7661	63.7406
38	74.1797	0.0135	609.8305	0.0016	8.2210	0.1216	7.8141	64.2394
39	83.0812	0.0120	684.0102	0.0015	8.2330	0.1215	7.8582	64.6967
40	93.0510	0.0107	767.0914	0.0013	8.2438	0.1213	7.8988	65.1159
41	104.2171	0.0096	860.1424	0.0012	8.2534	0.1212	7.9361	65.4997
42	116.7231	0.0086	964.3595	0.0010	8.2619	0.1210	7.9704	65.8509
43	130.7299	0.0076	1081.0826	0.0009	8.2696	0.1209	8.0019	66.1722
44	146.4175	0.0068	1211.8125	0.0008	8.2764	0.1208	8.0308	66.4659
45	163.9876	0.0061	1358.2300	0.0007	8.2825	0.1207	8.0572	66.7342
46	183.6661	0.0054	1522.2176	0.0007	8.2880	0.1207	8.0815	66.9792
47	205.7061	0.0049	1705.8838	0.0006	8.2928	0.1206	8.1037	67.2028
48	230.3908	0.0043	1911.5898	0.0005	8.2972	0.1205	8.1241	67.4068
49	258.0377	0.0039	2141.9806	0.0005	8.3010	0.1205	8.1427	67.5929
50	289.0022	0.0035	2400.0182	0.0004	8.3045	0.1204	8.1597	67.7624