DEPARTMENT OF STATISTICS AND DEMOGRAPHY

MAIN EXAMINATION, 2017/18

COURSE TITLE:	OPERATIONS RESEARCH II
COURSE CODE:	ST 408
TIME ALLOWED:	THREE (3) HOURS
INSTRUCTION:	ANSWER SECTION A AND ANY THREE QUESTIONS IN SECTION B
SPECIAL REQUIREMENTS:	SCIENTIFIC CALCULATORS AND STATISTICAL TABLES

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SECTION A

Question 1

(a) Given the profit payoff table given below, suppose the manager has assigned probabilities of 0.2 to the occurrence of state #1, 0.5 to the occurrence of state #2 and 0.3 to the occurrence of state #.

	State of Nature		
Alternative	#1	#2	#3
A	E12,000	E18,000	E15,000
B	E17,000	E10,000	E14,000
C	E22,000	E16,000	E10,000
D	E14.000	E14.000	E14.000

(i) Which alternative would you choose using the Expected Value Criterion?

(ii) Calculate the expected value of perfect information using (1) the expected payoff under certainty approach and (2) the expected regret approach. **(10 marks)**

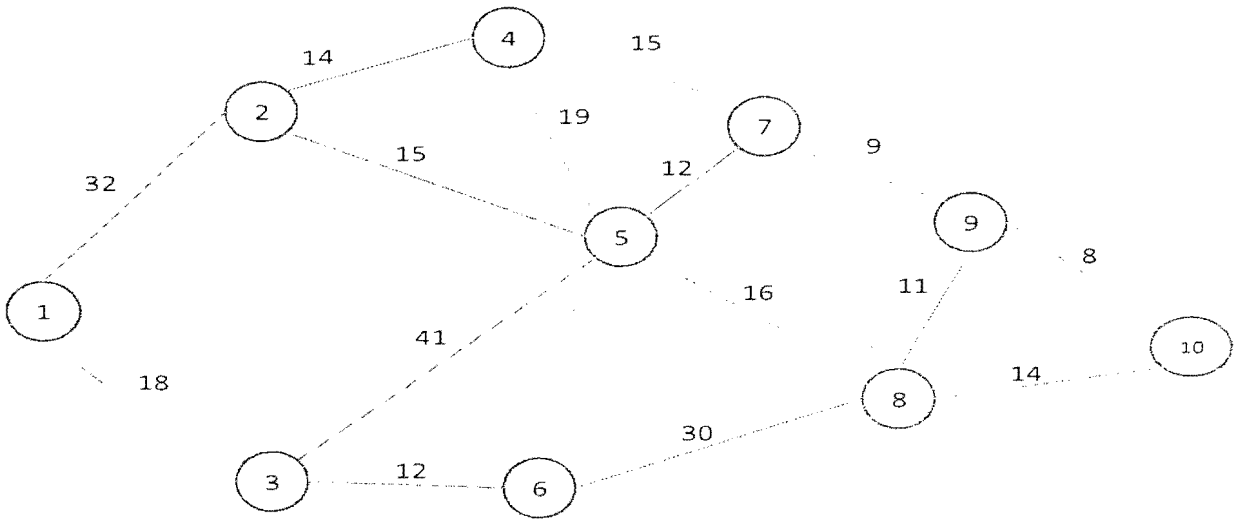
b. A manager must decide how many machines of a certain type to buy. The manager has narrowed the decision to two alternatives: (1) buy one machine or (2) buy two machines. If only one machine is purchased and demand is more than the company can handle, then a second machine will be purchased at a later date. However, the cost per machine would be lower if two machines were to be purchased at the same time. The initial purchase of the two machines has a net value of $75, 000 if demand is low and $140, 000 if demand is high. The probability of low demand is 0.45. The initial purchase of one machine has a net value of $85, 000 if demand is low. If demand is high, and the company decides to purchase machine initially, the manager has three options. The first option is to do nothing with a net value of $85, 000. The second option is to subcontract. If the firm decides to subcontract, there is a 65% chance of using vendor X with a net return of $100, 000. There is a 35 % chance of using vendor Y with a net return of $135, 000. The third option is to purchase a second machine with a net value of $115, 000. How many machines should the firm purchase initially and why? Use a decision tree to analyse the problem.

(15 marks)

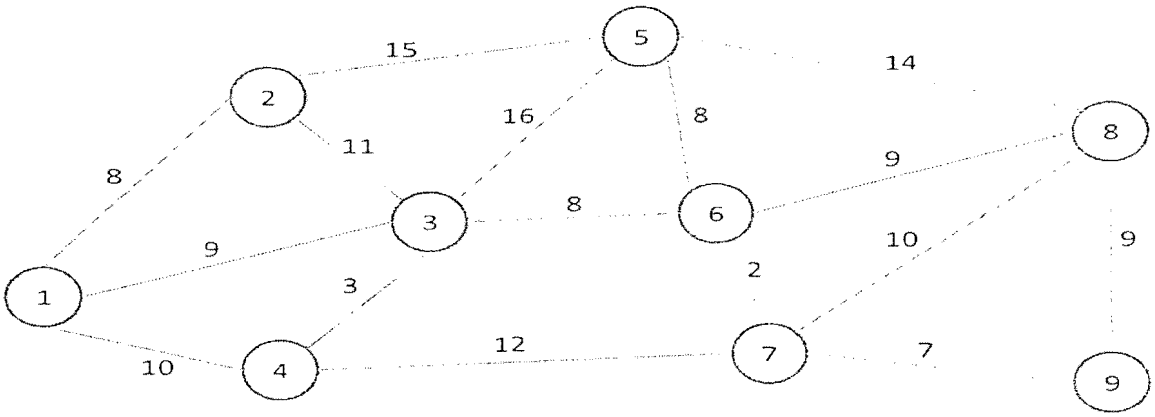
SECTION B

Question 2

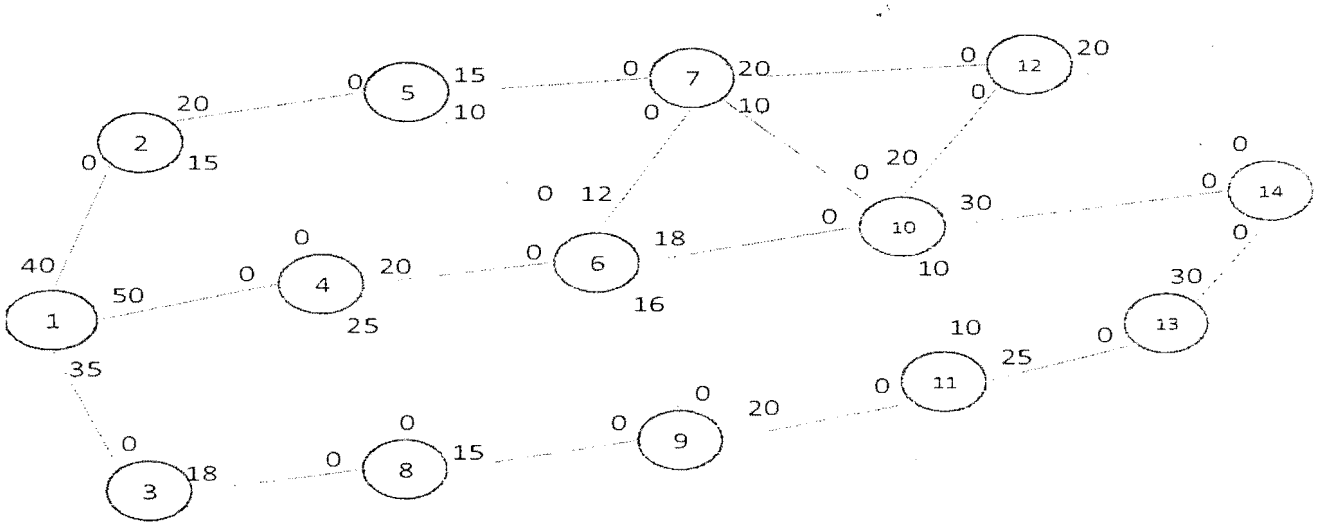
(a) Approximate travel times between various customer locations are shown on the accompanying network. Assume all delivery trucks from Node 1, find the shortest travel time to each customer location. **(8 marks)**



(b) Find the set of arcs that will interconnect all the nodes of this network using as little of the arc material as possible. **(7 marks)**



(c) The accompanying network represents a possible design for a system of pipelines for an oil field. Determine the maximal flow of oil based on flow capacities given in the network from the oil field on node 1 to the refinery at node 14. **(10 marks)**



Question 3

Residents of Mahlabatsini community buy their Christmas trees from one of three local dealers. The following switching probabilities have been determined:

		This year		
		A	B	C
Last year	A	0.65	0.25	0.10
	B	0.35	0.60	0.05
	C	0.40	0.30	0.30

Determine the steady state probability of customers for each dealer. **(25 marks)**

Question 4

(a). A machine shop handles tools repairs in a large company. Each job is assigned a priority when it arrives in the shop that is based on the urgency for that tool. Requests for repair can be described by a Poisson distribution. Arrival rates are $\lambda_1 = 2$ per hour, $\lambda_2 = 2$ per hour, and $\lambda_3 = 1$ per hour. The service rate is one tool per hour for each server, and there are six servers in the shop. Determine the following information:

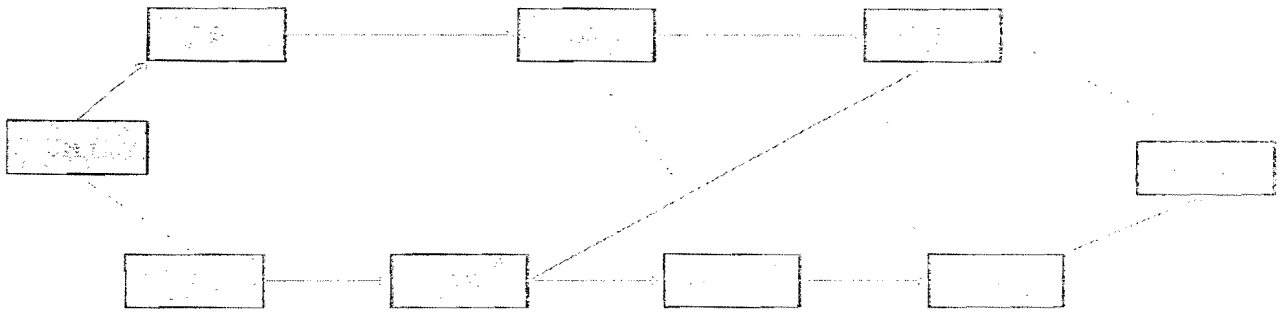
(i) The system utilization.
(ii) The average time a tool in each of the priority classes will wait for service.
(iii)The average time a tool spends in the system for each priority class.
(iv)The average number of tools waiting for repair in each class. **(15 marks)**

(b). Suppose the manager of the repair shop, after consulting with the managers of the departments that use the shop's services, has been able to revise the list of tools that are given the highest priorities. This would be reflected by revised arrival rates. Suppose that the revised rates are $\lambda_1 = 1.5$, $\lambda_2 = 2.5$, and λ_3 remains unchanged at 1.0. Determine the following information:

(i) The system utilization.
(ii) The average waiting time for units in each priority class. **(10 marks)**

Question 5

Consider the following project network and activity times (in days).



Activity	A	B	C	D	E	F	G
Time	3	2	5	5	6	2	2

The crashing data for this project are as follows:

	Time (Days)		Cost ($)	
Activity	Normal	Crash	Normal	Crash
A	3	2	800	1400
B	2	1	1200	1900
C	5	3	2000	2800
D	5	3	1500	2300
E	6	4	1800	2800
F	2	1	600	1000
G	2	1	500	1000

a. Find the critical path and the expected project completion time. **(10 marks)**
b. What is the total project cost using the normal time? **(2 marks)**
c. What activities should be crashed if management desires to complete the project in 12 days? What is the total project cost for the 12-day completion time? **(13 marks)**

Question 6

(a). Economic production quantity. The Dine Corporation is both a producer and a user of brass couplings. The firm operates 220 days a year and uses the couplings at a steady rate of 50 per day. Couplings can be produced at a rate of 200 per day. Annual storage cost is $2 per coupling, and machine setup cost is $70 per run.

(i) Determine the economic run quantity.
(ii) Approximately how many runs per year will there be?
(iii)Compute the maximum inventory level.
(iv)Determine the length of the pure consumption portion of the cycle. **(16 marks)**

(b). Single-period model. A firm that installs cable TV systems uses a certain piece of equipment for which it carries two spare parts cost $500 each and have no salvage value. Part failures can be modelled by a Poisson distribution with a mean of two failures during the useful life of the equipment. Holding and disposal costs are negligible. Estimate the apparent rage of shortage cost. **(9 marks)**

END OF EXAM!!

Standard Normal Probabilities

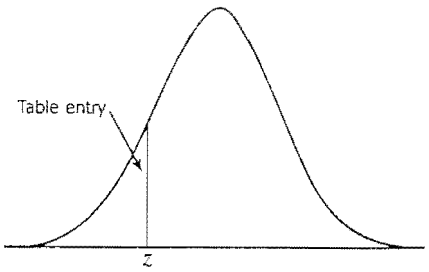


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−0.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−0.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−0.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−0.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−0.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−0.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−0.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−0.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−0.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−0.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

Standard Normal Probabilities

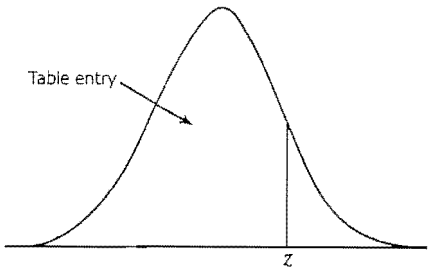


Table entry for z is the area under the standard normal curve to the left of z.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998