DEPARTMENT OF STATISTICS AND DEMOGRAPHY

MAIN EXAMINATION, 2013/14

COURSE TITLE:	OPERATIONS RESEARCH II
COURSE CODE:	ST 408
TIME ALLOWED:	THREE (3) HOURS
INSTRUCTION:	ANSWER <u>QUESTION ONE</u> AND <u>ANY THREE</u> QUESTIONS QUESTION 1 CARRIES 40 MARKS AND THE OTHER FOUR QUESTIONS EACH CARRY 20 MARKS
SPECIAL REQUIREMENTS:	SCIENTIFIC CALCULATORS AND STATISTICAL TABLES

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Question 1

(A) The director of personnel of Management Resources Inc. is in the process of designing a program that its customers can use in the job-finding process. Some of the activities include preparing resumes, writing letters and making appointments to see prospective employers, researching companies and so on. Some of the information on activities is shown in the following table:

Activity	t_o	Days t_m	t_p	Immediate Predecessor
A	8	10	12	-
B	6	7	9	-
C	3	3	4	-
D	10	20	30	A
E	6	7	8	C
F	9	10	11	B, D, E
G	6	7	10	B, D, E
H	14	15	16	F
I	10	11	13	F
J	6	7	8	G, H
K	4	7	8	I, J
L	1	2	4	G, H

(a) Construct a network for this problem. **(6 marks)**
(b) Determine the expected time and variance for each activity **(12 marks)**
(c) Determine ES, EF, LS, LF and slack for each activity **(6 marks)**
(d) Determine the critical path and project completion time **(2 marks)**
(e) Determine the probability that the project will be finished in 70 days or less **(4 marks)**

(B) The project described below has just begun and is scheduled to be completed in 11 weeks. If there is a penalty of E5 000 for each week that the project is late, what is the probability of incurring a penalty of at least E5 000?

| Activity	Estimated time (weeks)	Standard deviation (weeks)	
1-2	4	0.7	
1-3	3	0.62	
2-4	6	0.9	
3-4	9	1.9	**(10 marks)**

Question 2

Swazi Agricultural Suppliers is developing a new fertilizer. If the company markets the product and it is successful, the company will earn E150, 000 profit; if it is unsuccessful, the company will loose E75, 000. In the past, similar products have been successful 60% of the time. At a cost of E15, 000, the effectiveness of the new fertilizer can be tested. If the test result is favourable, there is an 80% chance that the fertilizer will be successful. If the test result is unfavourable, there is only a 30% chance that the fertilizer will be successful. There is a 60% chance of a favourable test result and 40% chance of an unfavourable test result.

    (a) Determine the company's optimal strategy. **(12 marks)**
    (b) Find Expected Value of Sample Information (EVSI) and the Expected Value of Perfect Information (EVPI) **(8 marks)**
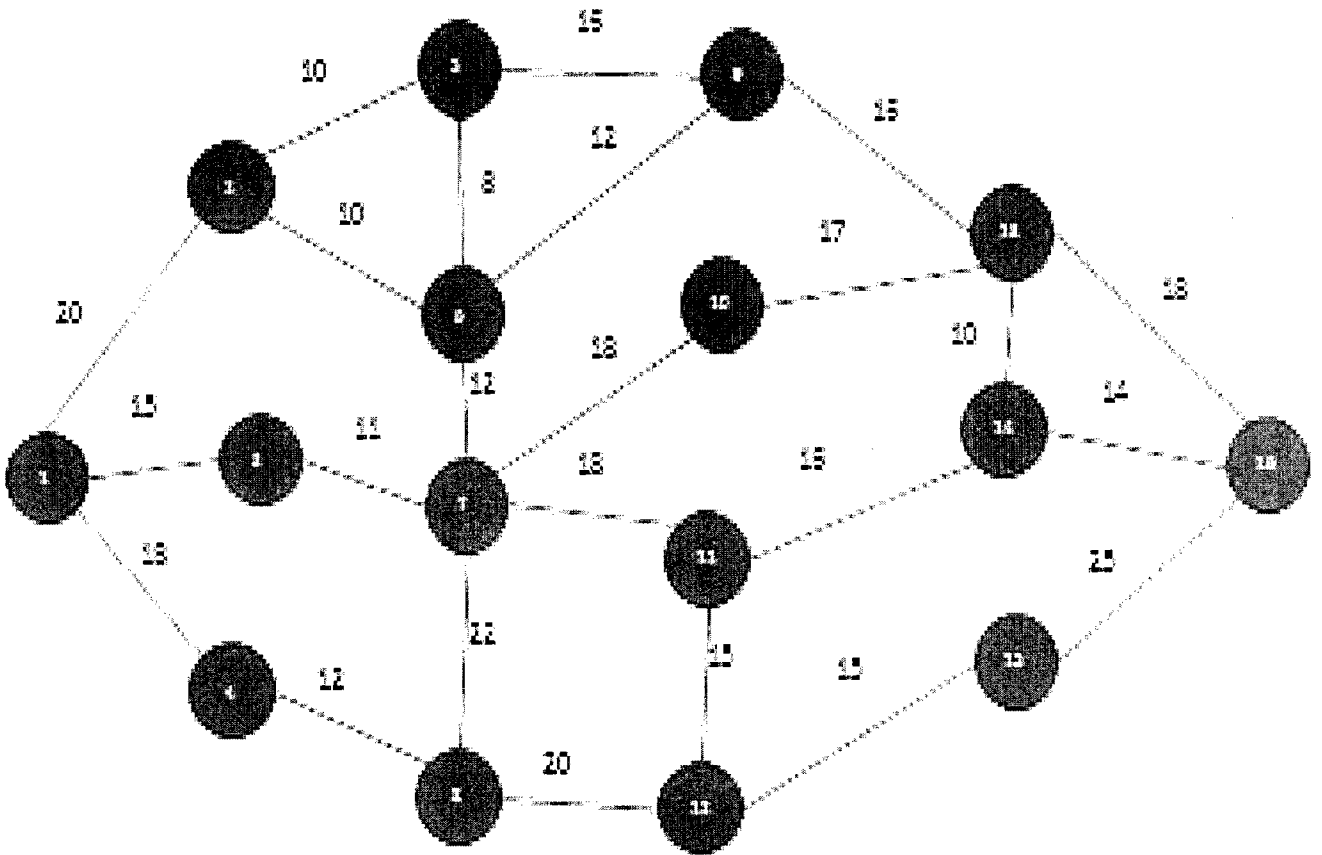
Question 3

(a) Solve the minimal spanning tree problem in the network below. The numbers in the network represent distance in hundreds of meters.

(5 marks)

3
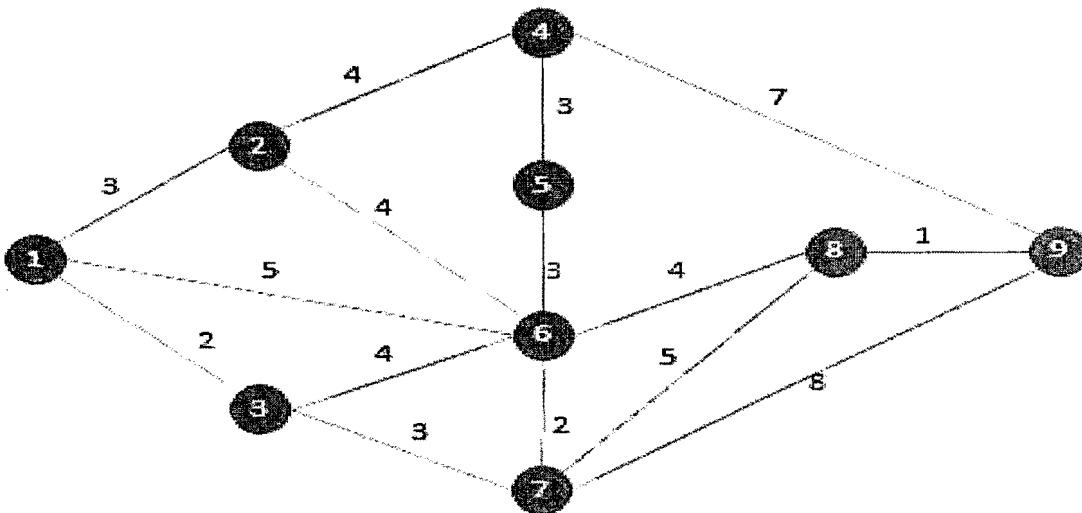
(b) What is the shortest route from Node 1 to Node 16. All numbers represent kilometres between German towns near the Black Forest.

(5 marks)

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(c) The road system around the hotel complex on International Drive (Node 1) to Disney World (Node 11) in Orlando, Florida is shown in the network below. The numbers by the nodes represent the traffic flow in hundreds of cars per hour. What is the maximum flow of cars from the hotel complex to Disney World?

(10 marks)
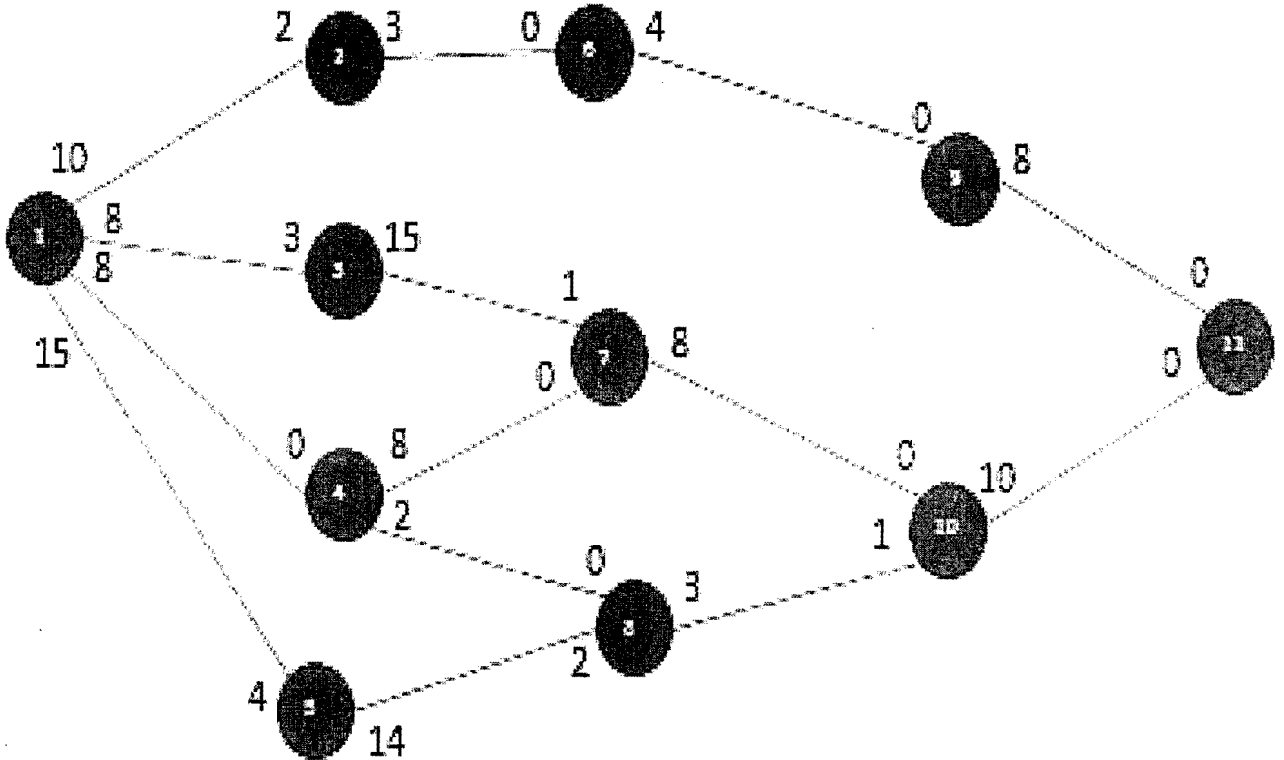
Question 4

A wholesale manager sells packets of ginger biscuits at the following prices:

Quantity	Unit Price
Less than 1000 packets	E5.00
1 000 – 3 999	E4.95
4 000 – 5 999	E4.90
6 000 or more	E4.85

Ordering costs are E50, annual holding cost is 40 percent of the purchase price and monthly usage is 6 000 packets. Determine an order quantity that will minimize total cost and determine the minimum total cost.   **(20 marks)**

Question 5

(a) The following information is available on a particular item:
Annual usage = 12, 000 units; Ordering costs = $60 per order; item unit cost = $10; carrying cost is 10% of unit cost of the item and lead time = 10 days. Assuming that there are 300 working days a year; Determine:

(i)The economic order quantity and number of orders per year?   **(6 marks)**

(ii) In the past two years, the usage rate has gone as high as 70 units per day. For a reordering system based on the inventory level, what should be the safety stock? What should be the reorder level at this safety stock?   **(4 marks)**

(b) Trucks arrive at the loading dock of a wholesale grocery at the rate of 1.2 per hour. A single crew consisting of two workers can load a truck in about 30 minutes. Crew members receive $50 per hour in wages and fringe benefits, and trucks drivers reflect an hourly cost of $60. The manager is thinking of adding another member to the crew. The service rate would then be 2.4 trucks per hour. Assume rates are Poisson.
(i) Would the third crew member be economical?
(ii) Would a fourth member be justifiable if the resulting service capacity were 2.6 trucks per hour?
                                                                                    (10 marks)

END OF EXAM!!

Table A.3 Standard Normal Curve Areas

$\Phi(z) = P(Z \le z)$

Standard normal density function

Shaded area = $\Phi(z)$
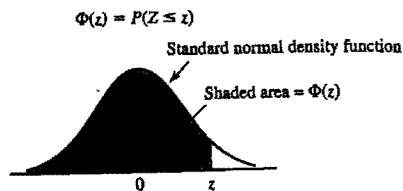
z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0017	.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	.0038
−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	.0352	.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	.0722	.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	.3482
−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

(continued)

Table A.3 Standard Normal Curve Areas *(cont.)*

$\Phi(z) = P(Z \le z)$

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	.9278	.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