PRACTICE QUESTIONS
MIDTERM EXAM

SECTION I: MULTIPLE CHOICE

1. Operations management is responsible for orchestrating all the resources needed to produce the final product. This includes all of the following except
   A) obtaining customer feedback
   B) arranging schedules
   C) managing inventory
   D) controlling quality
   E) designing work methods

2. Suppose that last month the cost of inputs summed to $100,000, and the value of outputs summed to $800,000. For which of the following values this month would productivity *increase*?
   A) inputs = $110,000, outputs = $800,000
   B) inputs = $50,000, outputs = $400,000
   C) inputs = $200,000, outputs = $1,600,000
   D) inputs = $100,000, outputs = $820,000
   E) (B) and (C)

3. Six-sigma quality implies how many average defects per million?
   A) 3.4
   B) 6σ
   C) 2600
   D) 34
   E) (A) and (B)

4. An example of an operation that does not add value is
   A) removing iron ore from the ground and shipping it to a steel mill
   B) filling the underground gasoline tanks at a service station
   C) making a wedding cake
   D) moving components to a warehouse for storage until the factory needs them
   E) moving luggage from a cab to the airport ticket counter

5. Suppose a firm ships 100 orders where the percent of errors is 0.05. The three sigma lower and upper limits for this process are
   A) [0, 0.12]
   B) [0, 0.05]
   C) [-.02, 0.12]
   D) [5, 95]
   E) None of the above

6. Compared to intermittent operations, repetitive operations
   A) are less specialized
   B) have greater efficiency
   C) have slower processing rates
   D) have more flexibility
   E) (A) and (B)

7. Suppose a process has a mean of 8.01 and a standard deviation of 0.03. The upper specification limit is 8.12 and the lower specification limit is 7.88. The capability index has a value of
   A) 1.22
   B) 1.33
   C) 1.44
   D) 1.55
   E) None of the above

8. The classes that you are taking at the university use a _____ process.
   A) project
   B) batch
   C) line
   D) continuous
   E) recycle

9. Which of the following is not characteristic of TQM?
   A) Inspecting products after they have been made
   B) Identifying and correcting the root causes of quality problems
   C) Encompasses the entire organization
   D) Attempts to embed quality in every aspect of the organization
   E) Concerned with technical aspects of quality

10. Suppose that you want to measure the percentage of candles that are cut longer than 9 inches. Which control chart would be appropriate?
   A) *x*-bar chart
   B) *R*-chart
   C) p-chart
   D) *c*-chart
   E) *x*-bar and *R*- charts

11. Which of the following is *not* typically considered to be a core competency?
   A) Workforce
   B) Mission
   C) Market understanding
   D) Technology
   E) Facilities

12. Jars of pickles are sampled and weighed. Sample measures are plotted on control charts. The ideal weight should be precisely 11 oz. Which type of chart(s) would you recommend?
   A) Process flow charts
   B) Scatter diagrams
   C) $\bar{x}$ and R-charts
   D) $\bar{x}$ but not R-charts
   E) All of the above

13. Service design differs from product design by including
   A) customer needs
   B) marketing personnel in the decision making process
   C) speed
   D) quality
   E) the aesthetic and psychological benefits of the product

14. Which of the following is not characteristic of intermittent operations?
A) Produce many different products with varying processing requirements
B) Capital intensive
C) Workers need to be able to perform different tasks depending on the processing needs of the product
D) General purpose equipment
E) Volume of goods produced directly tied to number of customer orders

15. Pre-fabricated furniture with choices of fabric colors is an example of which product and service strategy?
A) Make-to-stock
B) Assemble-to-order
C) Make-to-order
D) All of the above
E) None of the above

16. Suppose a system consists of 3 components with reliabilities $R_1=0.95$, $R_2=0.8$ *and* $R_3=0.9$ all of which must function for the system to function. If component 1 has a backup with reliability $R_B=0.95$, the reliability of the system is
A) 2.70
B) 0.68
C) 0.93
D) 0.72
E) None of the above

17. Activities on the critical path
A) are the ones with the longest activity times
B) have LS equal to LF
C) have no slack
D) (A) and (C)
E) All of the above

18. Suppose that a plant has a total productivity measure of 0.85. What can we conclude?
A) The plant is not earning profits
B) Nothing
C) The plant should lay off workers
D) The plant is highly automated
E) The daily productivity is excellent

19. Highly skilled hourly workers would be most needed by firms employing which of the following competitive priorities?
A) Location
B) Cost
C) Flexibility
D) Time
E) Product development speed

20. What is the upper control limit for a *c*-chart if the total defects found over 20 samples equals 150?
A) 7.5
B) 2.739
C) 15.72
D) 20
E) 30

21. Which one of the following products is most likely made in a job shop environment?
    A) A daily newspaper
    B) Canned vegetables
    C) Business cards
    D) Television sets
    E) None of the above

22. Suppose a process has a mean of 42 and a standard deviation of 5. The upper specification limit is 50 and the lower specification limit is 35. The capability index has a value of
    A) 0
    B) 0.500
    C) 0.533
    D) 0.467
    E) None of the above

23. According to the product-process matrix as volume increases and product variety decreases
    A) standardization and specialized equipment become more economically feasible
    B) standardization and specialized equipment becomes less economically feasible
    C) more highly skilled workers should be used
    D) resources should be arranged in sequence
    E) (A) and (D)

24. A network has been crashed to the point where all activities are critical. Additional crashing
    A) is unnecessary
    B) is impossible
    C) is prohibitively expensive
    D) may require crashing multiple tasks simultaneously
    E) can be done, but all critical tasks must be reduced in duration

25. Suppose a system consists of 4 components with reliabilities $R_1=0.9$, $R_2=0.85$, $R_3=0.85$ *and* $R_4=0.9$ all of which must function for the system to function. If components 2 and 4 each have a backup with reliability $R_B=0.9$, the reliability of the system is
    A) 0.59
    B) 0.69
    C) 0.75
    D) 0.90
    E) None of the above

26. A manager has just replaced three workers with a machine that is cheaper to operate than the cost of the three replaced workers. Output is expected to remain the same. Which of the following is true?
    A) Labor productivity will decrease
    B) Machine productivity will increase
    C) Multifactor productivity will decrease
    D) Multifactor productivity will increase
    E) None of the above

27. Which of the following scenarios illustrates a moment that meets the customer's expectations?
    A) A professor contacts people in several companies to find you a job
    B) A flight attendant responds after being called
    C) A bank sends you monthly investment advice
    D) A sales clerk calls you by your name on your second visit to the store
    E) A sales clerk that asked you to wait as soon as a wealthy-looking customer entered the store

28. Suppose a facility has a partial productivity measure of 1.5. We can conclude
    A) The facility should lay off workers
    B) The firm should increase output
    C) The facility is not earning a profit
    D) The firm is earning a profit
    E) Nothing

29. The LCL and UCL for a 3σ *c*-chart where the total number of customer complaints over 30 weeks equals 45 is
    A) 1.5
    B) [0, -2.17]
    C) [-2.17, 5.17]
    D) [0, 5.17]
    E) None of the above

30. Which of the following statements regarding CPM networks is true?
    A) There can be multiple critical paths on the same project, all with different durations.
    B) The early finish of an activity is the latest early start of all preceding activities.
    C) If a specific project has multiple critical paths, all of them will have the same duration.
    D) The late start of an activity is its late finish plus its duration.
    E) All of the above are true.

31. A nationwide parcel delivery service keeps track of the number of late deliveries (more than 30 minutes past the time promised to clients) per day. They plan on using a control chart to plot their results. Which type of control chart(s) would you recommend?
    A) p-charts
    B) c-charts
    C) $\bar{x}$ -, but not R-charts
    D) $\bar{x}$ - and R-charts
    E) both p- and c-charts

32. The LCL and UCL for a 3σ chart where there are 10 samples and the number of customer complaints for each is

1	2	3	4	5	6	7	8	9	10
5	6	3	0	2	2	1	5	6	3

    A) 3.3
    B) [0, 5.17]
    C) [-2.15, 8.75]
    D) [0, 8.75]
    E) None of the above

33. Which of the following is false regarding control charts?
    A) Control charts are built so that new data can be quickly compared to past performance data.
    B) Values above the UCL always imply that the product's quality exceeds expectations.
    C) Control charts graphically present data.
    D) Control charts plot data over time.
    E) None of the above is false.

34. Consider a p chart measuring the percentage of defective light bulbs. Suppose the LCL is 0.04 and a sample has 1% defective items. We can conclude
    A) The process is stable.
    B) The process is unstable.
    C) An x-bar and R chart is needed.
    D) The UCL is required.
    E) Nothing.

35. Computers Inc. provides customized PCs at a competitive price with quick delivery. It uses a
    A) make-to-stock strategy
    B) make-to-deliver strategy
    C) make-to-order strategy
    D) assemble-to-order strategy
    E) None of the above

36. Which of the following statements concerning CPM activities is false?
    A) The early finish of an activity is the early start of that activity plus its duration
    B) The late finish is the earliest of the late start times of all successor activities
    C) The late start of an activity is its late finish less its duration
    D) The late finish of an activity is the earliest late start of all preceding activities
    E) The early start of an activity is the latest early finish of all preceding activities

37. Suppose a manager wants to build 3σ control limits for a process with the following data. The standard deviation of the process is 2.

	Sample					
Observation	1	2	3	4	5	6
1	5.5	4.5	4.9	5.4	5.2	4.7
2	5.1	4.6	4.7	5.1	4.8	5.2

    The UCL and LCL for the R chart are
    A) [0, 1.03] and the process is stable
    B) [0, 1.03] and the process is unstable
    C) [4.38, 5.57] and the process is stable
    D) [4.38, 5.57] and the process is unstable
    E) None of the above

38. Which of the following is false regarding random causes of variation?
    A) They affect almost every production process
    B) They are the many sources of variation that occur when a process is under control
    C) They are variations that can be traced to a specific cause
    D) They are tolerated, within limits, when a process is under control
    E) All of the above are true.

39. Statistical process control charts
    A) display the measurements on every item being produced
    B) display upper and lower limits for process variables or attributes and signal when a process is no longer in control
    C) indicate to the process operator the average outgoing quality of each lot
    D) indicate to the operator the true quality of material leaving the process
    E) none of the above

40. Plots of sample ranges indicate that the most recent value is below the lower control limit. What course of action would you recommend?
    A) Since there is no obvious pattern in the measurements, variability is in control.
    B) One value outside the control limits is insufficient to warrant any action.
    C) Lower than expected dispersion is a desirable condition; there is no reason to investigate.
    D) Reject the last units produced.
    E) Process is not in control; investigate what created this condition.

SECTION II: PROBLEMS

1. Bottles of coffee are supposed to have a net weight of 4 ounces. Inspectors want to develop process control charts. They take samples of 6 bottles and weigh them. They obtained the following data.

Sample	1	2	3	4	5	6	7	8
Mean	4.00	4.16	3.99	4.00	4.17	3.93	3.98	4.01
Range	0.41	0.55	0.44	0.48	0.56	0.62	0.54	0.44

Is this process in stable?

2. Consider the following data on the weights for bags of candy. Each sample contains 4 bags and the population standard deviation is 6.

Sample	1	2	3	4	5	6
Mean	15.00	14.40	14.60	15.75	16.05	16.50
Range	2.2	3.3	2.9	3.4	2.8	4.3

a) Determine if this process is stable using 3σ control limits. Explain which chart you would use.
b) Suppose the manager collects 2 more samples with means 16.80 and 17.25. Based on the control limits calculated in part (a), is this process stable?

3. Consider the following data on the weights for bags of candy. Each bag should contain 28 pieces of candy with a target mean weight of 150 grams.

	Sample							
Observation	1	2	3	4	5	6	7	8
1	144	151	156	156	153	156	149	154
2	150	153	151	159	153	160	158	155
3	161	160	154	161	153	156	158	161
4	160	158	164	162	153	154	149	152
5	155	159	148	150	153	162	156	144

a) Create an x-bar and R chart using 3σ control limits.
b) Is this process stable?

4. Eight samples of with 50 observations were taken by an operator at a workstation in a production process. The number of defective items in each sample was recorded as follows.

Sample	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Number of Defects	10	0	12	8	10	16	14	10

Is the process in a state of control?

5. Consider a project having the following seven activities:

Activity	**Immediate Predecessors**	**Optimistic Time (weeks)**	**Most Likely Time (weeks)**	**Pessimistic Time(weeks)**
A	-	2	3	4
B	A	4	4	8
C	A	3	5	7
D	B	5	5	5
E	B, C	3	6	7
F	D	4	5	9
G	E, F	3	3	7

a) Using a forward and backward pass through the network, determine the expected completion time for the project and the critical path.
b) What is the expected completion time required to have a 90% chance of finishing the project in 23 weeks?

6. Consider a project consisting of the following activities.

Activity	**Immediate Predecessors**	**Normal Time (weeks)**	**Crash Time (weeks)**	**Normal Cost $**	**Crash Cost $**
A	None	4	3	3000	6000
B	None	4	3	5000	7000
C	A	9	7	2000	6000
D	A, B	2	2	3000	3000
E	B	15	12	4000	7000
F	C, D	7	5	4000	5000
G	E, F	5	3	2000	5200

a) How would you crash this project by 2 weeks? What is the cost?
b) Suppose your client would like the project completed in 23 weeks. The late penalty is $300 per day and overhead costs the firm $500 per day. How would you crash this project?

TABLE: FACTORS FOR 3σ CONTROL LIMITS OF X-BAR AND R CHARTS

	Factor for x-chart	Factors for R-chart	
Sample Size (*n*)	A_2	D_3	D_4
2	1.88	0	3.27
3	1.02	0	2.57
4	0.73	0	2.28
5	0.58	0	2.11
6	0.48	0	2.00
7	0.42	0.08	1.92
8	0.37	0.14	1.86

TABLE: THE STANDARD NORMAL DISTRIBUTION

This table gives the area under the standardized normal curve from 0 to z, as shown by the shaded portion of the following figure.

Examples: If z is the standard normal random variable, then

Prob $(0 \le z \le 1.32) = 0.4066$

Prob $(z \ge 1.32) = 0.5000 - 0.4066 = 0.0934$

Prob $(z \le 1.32) =$ Prob $(z \le 0) +$ Prob $(0 \le z \le 1.32)$

$= 0.5000 + 0.4066 = 0.9066$

Prob $(z \le -1.32) =$ Prob $(z \ge 1.32) = 0.0934$ (by symmetry)

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2518	0.2549
0.7	0.2580	0.2612	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4986	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.5	0.4998									

Source: Adapted from Robert Markland, *Topics in Management Science*, 3rd ed. New York: John Wiley & Sons, 1989.