

CBCS SCHEME

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BME755C

Seventh Semester B.E./B.Tech. Degree Examination, June/July 2026 Operations Research

Time: 3 hrs.

Max. Marks: 100

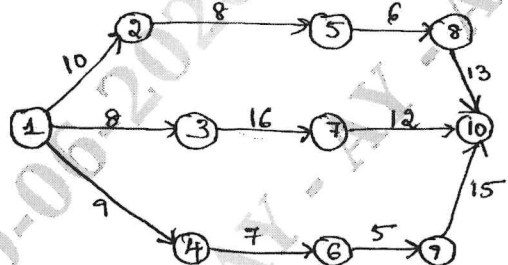
*Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.*

Module – 1			M	L	C																													
Q.1	a.	Define the following with reference to LPP : i) Slack variable ii) Basic Feasible solution iii) Optimum solution.	3	L1	CO1																													
	b.	Explain the main phases of Operation Research.	7	L2	CO1																													
	c.	Solve the following LPP by using Simplex method : Max. $Z = 6x + 8y$ Subject to the constraints $x + y \leq 10$ $2x + 3y \leq 25$ $x + 5y \leq 35$ and $x, y \geq 0$.	10	L3	CO1																													
OR																																		
Q.2	a.	Define Operation Research.	3	L1	CO1																													
	b.	Explain the limitations of OR.	7	L2	CO1																													
	c.	Solve LPP by graphical method : Maximize $Z = 3x + 5y$ Subject to the constraints $x \leq 4$ $2y \leq 12$ $3x + 2y \leq 18$, where $x, y \geq 0$.	10	L3	CO1																													
Module – 2																																		
Q.3	a.	List the difference between the transportation problem and assignment problem.	6	L1	CO2																													
	b.	Solve the following transportation problem : Destination <table><tr><td></td><td>P</td><td>Q</td><td>R</td><td>S</td><td>Supply</td></tr><tr><td>A</td><td>21</td><td>16</td><td>25</td><td>13</td><td>11</td></tr><tr><td>B</td><td>17</td><td>18</td><td>14</td><td>23</td><td>13</td></tr><tr><td>C</td><td>32</td><td>17</td><td>18</td><td>41</td><td>19</td></tr><tr><td>Demand</td><td>6</td><td>10</td><td>12</td><td>15</td><td>43</td></tr></table>		P	Q	R	S	Supply	A	21	16	25	13	11	B	17	18	14	23	13	C	32	17	18	41	19	Demand	6	10	12	15	43	8	L3
	P	Q	R	S	Supply																													
A	21	16	25	13	11																													
B	17	18	14	23	13																													
C	32	17	18	41	19																													
Demand	6	10	12	15	43																													
	c.	Determine the travelling salesman problem for cost route. <table><tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td></tr><tr><td>A</td><td>-</td><td>46</td><td>16</td><td>40</td></tr><tr><td>B</td><td>41</td><td>-</td><td>50</td><td>40</td></tr><tr><td>C</td><td>82</td><td>32</td><td>-</td><td>60</td></tr><tr><td>D</td><td>40</td><td>40</td><td>36</td><td>-</td></tr></table>		A	B	C	D	A	-	46	16	40	B	41	-	50	40	C	82	32	-	60	D	40	40	36	-	6	L2	CO2				
	A	B	C	D																														
A	-	46	16	40																														
B	41	-	50	40																														
C	82	32	-	60																														
D	40	40	36	-																														

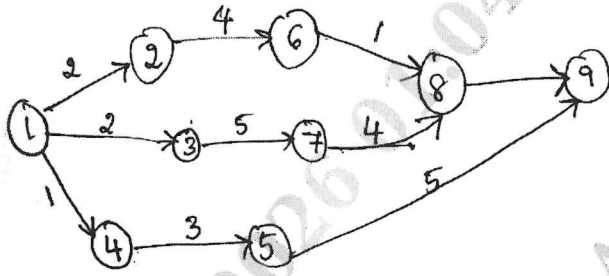
OR

Q.4	a.	List the “Hungarian method steps” to solve assignment problem.	4	L1	CO2																																				
	b.	<p>A company has 4 machines to do 5 jobs. Each job can be assigned to only one machine. The cost of each job on each machine is given below. Determine the job assignments that will minimize the total cost.</p> <table><tr><td></td><td>M1</td><td>M2</td><td>M3</td><td>M4</td></tr><tr><td>C1</td><td>9</td><td>14</td><td>19</td><td>15</td></tr><tr><td>C2</td><td>7</td><td>17</td><td>20</td><td>19</td></tr><tr><td>C3</td><td>9</td><td>18</td><td>21</td><td>18</td></tr><tr><td>C4</td><td>10</td><td>12</td><td>18</td><td>19</td></tr><tr><td>C5</td><td>10</td><td>15</td><td>21</td><td>16</td></tr></table>		M1	M2	M3	M4	C1	9	14	19	15	C2	7	17	20	19	C3	9	18	21	18	C4	10	12	18	19	C5	10	15	21	16	8	L2	CO2						
	M1	M2	M3	M4																																					
C1	9	14	19	15																																					
C2	7	17	20	19																																					
C3	9	18	21	18																																					
C4	10	12	18	19																																					
C5	10	15	21	16																																					
	c.	<p>The owner of small machine shop has four machines to assign jobs for the day. 5 jobs are offered with expected profit for each mechanic on jobs.</p> <table><tr><td></td><td colspan="5">Job</td></tr><tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>1</td><td>62</td><td>78</td><td>50</td><td>111</td><td>82</td></tr><tr><td>2</td><td>71</td><td>84</td><td>61</td><td>73</td><td>59</td></tr><tr><td>3</td><td>87</td><td>92</td><td>111</td><td>71</td><td>81</td></tr><tr><td>4</td><td>48</td><td>64</td><td>87</td><td>77</td><td>80</td></tr></table> <p>Find the assignment of mechanics to the job that will results in maximum profit.</p>		Job						A	B	C	D	E	1	62	78	50	111	82	2	71	84	61	73	59	3	87	92	111	71	81	4	48	64	87	77	80	8	L3	CO2
	Job																																								
	A	B	C	D	E																																				
1	62	78	50	111	82																																				
2	71	84	61	73	59																																				
3	87	92	111	71	81																																				
4	48	64	87	77	80																																				

Module – 3

Q.5	a.	List the basic steps in CPM / PERT.	2	L1	CO3																										
	b.	Determine the early start and late start in respect to all node points and identify critical path for the following network. <div></div>	8	L2	CO3																										
	c.	A project has the following times schedule :	10	L2	CO3																										
		<table><tr><td>Activity</td><td>1-2</td><td>1-3</td><td>2-4</td><td>3-4</td><td>3-5</td><td>4-9</td><td>5-6</td><td>5-7</td><td>6-8</td><td>7-8</td><td>8-10</td><td>9-10</td></tr><tr><td>Time (days)</td><td>4</td><td>1</td><td>1</td><td>1</td><td>6</td><td>5</td><td>4</td><td>8</td><td>1</td><td>2</td><td>5</td><td>7</td></tr></table> <div><div>i)</div><div>ii)</div><div>iii)</div><div>iv)</div><div>Construct the network diagram.</div><div>Compute the earliest event time and latest event time</div><div>Determine the critical path</div><div>Compute float for each activity.</div></div>	Activity	1-2	1-3	2-4	3-4	3-5	4-9	5-6	5-7	6-8	7-8	8-10	9-10	Time (days)	4	1	1	1	6	5	4	8	1	2	5	7			
Activity	1-2	1-3	2-4	3-4	3-5	4-9	5-6	5-7	6-8	7-8	8-10	9-10																			
Time (days)	4	1	1	1	6	5	4	8	1	2	5	7																			
OR																															

OR

Q.6	a.	Define the following : i) Total float ii) Free float iii) Independent float iv) Optimistic time v) Pessimistic time.	5	L1	CO3																																																				
	b.	Describe the critical path and slack time for the following network : 	5	L2	CO3																																																				
	c.	A project has the following characteristics : <table border="1" data-bbox="285 743 1217 1283"><thead><tr><th>Activity</th><th>Most Optimistic time (a)</th><th>Most Pessimistic time (b)</th><th>Most likely time (m)</th></tr></thead><tbody><tr><td>(1-2)</td><td>1</td><td>5</td><td>1.5</td></tr><tr><td>(2-3)</td><td>1</td><td>3</td><td>2</td></tr><tr><td>(2-4)</td><td>1</td><td>5</td><td>3</td></tr><tr><td>(3-5)</td><td>3</td><td>5</td><td>4</td></tr><tr><td>(4-5)</td><td>2</td><td>4</td><td>3</td></tr><tr><td>(4-6)</td><td>3</td><td>7</td><td>5</td></tr><tr><td>(5-7)</td><td>4</td><td>6</td><td>5</td></tr><tr><td>(6-7)</td><td>6</td><td>8</td><td>7</td></tr><tr><td>(7-8)</td><td>2</td><td>6</td><td>4</td></tr><tr><td>(7-9)</td><td>5</td><td>8</td><td>6</td></tr><tr><td>(8-10)</td><td>1</td><td>3</td><td>2</td></tr><tr><td>(9-10)</td><td>3</td><td>7</td><td>5</td></tr></tbody></table> <p>Construct a PERT Network. Find the critical path and variance for each event.</p>	Activity	Most Optimistic time (a)	Most Pessimistic time (b)	Most likely time (m)	(1-2)	1	5	1.5	(2-3)	1	3	2	(2-4)	1	5	3	(3-5)	3	5	4	(4-5)	2	4	3	(4-6)	3	7	5	(5-7)	4	6	5	(6-7)	6	8	7	(7-8)	2	6	4	(7-9)	5	8	6	(8-10)	1	3	2	(9-10)	3	7	5	10	L3	CO3
Activity	Most Optimistic time (a)	Most Pessimistic time (b)	Most likely time (m)																																																						
(1-2)	1	5	1.5																																																						
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(7-9)	5	8	6																																																						
(8-10)	1	3	2																																																						
(9-10)	3	7	5																																																						

Module – 4					
Q.7	a.	Explain the following : i) Max – min and Min – max ii) Pure strategy and mixed strategy iii) Zero sum game and two person zero sum game.	6	L2	CO4
	b.	Solve the following game graphically : <div style="text-align: center;">Player B B1 B2 B3</div> <div style="display: inline-block; vertical-align: middle;">Player A</div> <div style="display: inline-block; vertical-align: middle;"><div style="display: inline-block; vertical-align: middle;">A1</div><div style="display: inline-block; vertical-align: middle;">A2</div><div style="display: inline-block; vertical-align: middle;"><div style="display: inline-block; vertical-align: middle;">1</div><div style="display: inline-block; vertical-align: middle;">3</div><div style="display: inline-block; vertical-align: middle;">12</div><div style="display: inline-block; vertical-align: middle;">8</div><div style="display: inline-block; vertical-align: middle;">6</div><div style="display: inline-block; vertical-align: middle;">2</div></div></div>	8	L3	CO4
	c.	Solve the pay off matrix <div style="text-align: center;">Player B</div> <div style="display: inline-block; vertical-align: middle;">Player A</div> <div style="display: inline-block; vertical-align: middle;"><div style="display: inline-block; vertical-align: middle;">1</div><div style="display: inline-block; vertical-align: middle;">6</div><div style="display: inline-block; vertical-align: middle;">5</div><div style="display: inline-block; vertical-align: middle;">7</div><div style="display: inline-block; vertical-align: middle;">2</div><div style="display: inline-block; vertical-align: middle;">7</div><div style="display: inline-block; vertical-align: middle;">1</div><div style="display: inline-block; vertical-align: middle;">6</div></div>	6	L3	CO4

OR

Q.8	a.	List Kendall's notations for representing queuing model.	5	L1	CO4
	b.	Describe the characteristics of queuing models.	5	L2	CO4
	c.	In a railway marshalling yard goods trains arrive at a rate of 30 trains per day. Assuming that inter arrival time and service time distribution follows an exponential distribution with an average of 30 minutes. Calculate the following : i) The mean queue size. ii) The probability that queue size exceeds 10. iii) What will be the changes in (i) and (ii) if the input of the train increases to an average of 33 per day.	10	L3	CO4

Module – 5

Module - 3

Q.9	a.	List out the basic assumptions for solving sequencing problems.	3	L1	CO5																												
	b.	<p>Processing times and due dates for seven jobs waiting to be processed at a work center are given the following table. Determine the sequence of jobs, the average flow time , average tardiness and number of tardy jobs for each of the following priority rules : i) SPT rule ii) EDD rule.</p> <table><tr><td>Job</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr><tr><td>Processing Time (min)</td><td>5</td><td>10</td><td>8</td><td>4</td><td>15</td><td>20</td><td>8</td></tr><tr><td>Due date (min)</td><td>15</td><td>12</td><td>15</td><td>25</td><td>30</td><td>40</td><td>45</td></tr></table>	Job	A	B	C	D	E	F	G	Processing Time (min)	5	10	8	4	15	20	8	Due date (min)	15	12	15	25	30	40	45	9	L2	CO5				
Job	A	B	C	D	E	F	G																										
Processing Time (min)	5	10	8	4	15	20	8																										
Due date (min)	15	12	15	25	30	40	45																										
	c.	<p>There are 5 jobs each of which is to be processed through 3 machines A, B, C in the order ABC. Processing times in minutes are</p> <table><tr><td colspan="4">Machines</td></tr><tr><td>Jobs</td><td>A</td><td>B</td><td>C</td></tr><tr><td>1</td><td>6</td><td>8</td><td>14</td></tr><tr><td>2</td><td>16</td><td>10</td><td>18</td></tr><tr><td>3</td><td>14</td><td>2</td><td>10</td></tr><tr><td>4</td><td>10</td><td>4</td><td>12</td></tr><tr><td>5</td><td>8</td><td>6</td><td>20</td></tr></table> <p>Find the optimum sequence for the 5 jobs and the minimum elapsed time. Also find the idle time for 3 machines.</p>	Machines				Jobs	A	B	C	1	6	8	14	2	16	10	18	3	14	2	10	4	10	4	12	5	8	6	20	8	L3	CO5
Machines																																	
Jobs	A	B	C																														
1	6	8	14																														
2	16	10	18																														
3	14	2	10																														
4	10	4	12																														
5	8	6	20																														

OR

Q.10	a.	Determine the sequence that minimizes the total elapsed time required to complete the following tasks in two machines and also calculate the idle time for machines I and II.	5	L2	CO5																														
<table><tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr><tr><td>Machine A</td><td>5</td><td>3</td><td>12</td><td>15</td><td>6</td><td>10</td><td>11</td><td>9</td><td>5</td></tr><tr><td>Machine B</td><td>6</td><td>8</td><td>10</td><td>10</td><td>6</td><td>12</td><td>1</td><td>3</td><td>7</td></tr></table>			Job	1	2	3	4	5	6	7	8	9	Machine A	5	3	12	15	6	10	11	9	5	Machine B	6	8	10	10	6	12	1	3	7			
Job	1	2	3	4	5	6	7	8	9																										
Machine A	5	3	12	15	6	10	11	9	5																										
Machine B	6	8	10	10	6	12	1	3	7																										

	<p>b. Using Graphical method, find the optimal sequence needed to process Job 1 and Job 2 on 5 machines A, B, C, D and E. For each machine, determine the job which should be done first. Calculate the total time needed to complete both the jobs.</p> <table><tr><td>Job1</td><td>Sequence</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td></td><td>Time (hrs)</td><td>3</td><td>4</td><td>2</td><td>6</td><td>2</td></tr></table> <table><tr><td>Job2</td><td>Sequence</td><td>B</td><td>C</td><td>A</td><td>D</td><td>E</td></tr><tr><td></td><td>Time (hrs)</td><td>5</td><td>4</td><td>3</td><td>2</td><td>6</td></tr></table>	Job1	Sequence	A	B	C	D	E		Time (hrs)	3	4	2	6	2	Job2	Sequence	B	C	A	D	E		Time (hrs)	5	4	3	2	6	12	L3	CO5
Job1	Sequence	A	B	C	D	E																										
	Time (hrs)	3	4	2	6	2																										
Job2	Sequence	B	C	A	D	E																										
	Time (hrs)	5	4	3	2	6																										
	<p>c. Define :</p> <p>i) Total elapsed time</p> <p>ii) Idle time</p> <p>iii) EDD.</p>	3	L1	CO5																												
