NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

SBA1203

FACULTY OF APPLIED SCIENCE

DEPARTMENT OF STATISTICS AND OPERATIONS RESEARCH

SBA 1203: NETWORK MODELS

BSc. Business Analytics: Part I

SEPTEMBER 2024 EXAMINATION

Time : 3 hours

Candidates may attempt **ALL** Questions in Section **A** and at most **THREE** Questions in Section **B**. Each question should start on a fresh page.

SECTION A: Answer all questions in this section (40 marks).

A1. (a) List any 4 applications of the Maximum flow problem. [4]

(b) List any 2 advantages and any 2 disadvantages of using Gantt charts. [4]

A2. (a) Write down the relaxation condition for Dijkstra's algorithm. [4]

(b) Write down the general formular for Floyd-Warshall algorithm computations [4]

(c) State the Min-cut max-flow theorem. [4]

A3. Use the **Nearest Neighbourhood Search Algorithm** to compute the shortest possible route that visits each city exactly once and returns to the origin city. [10]

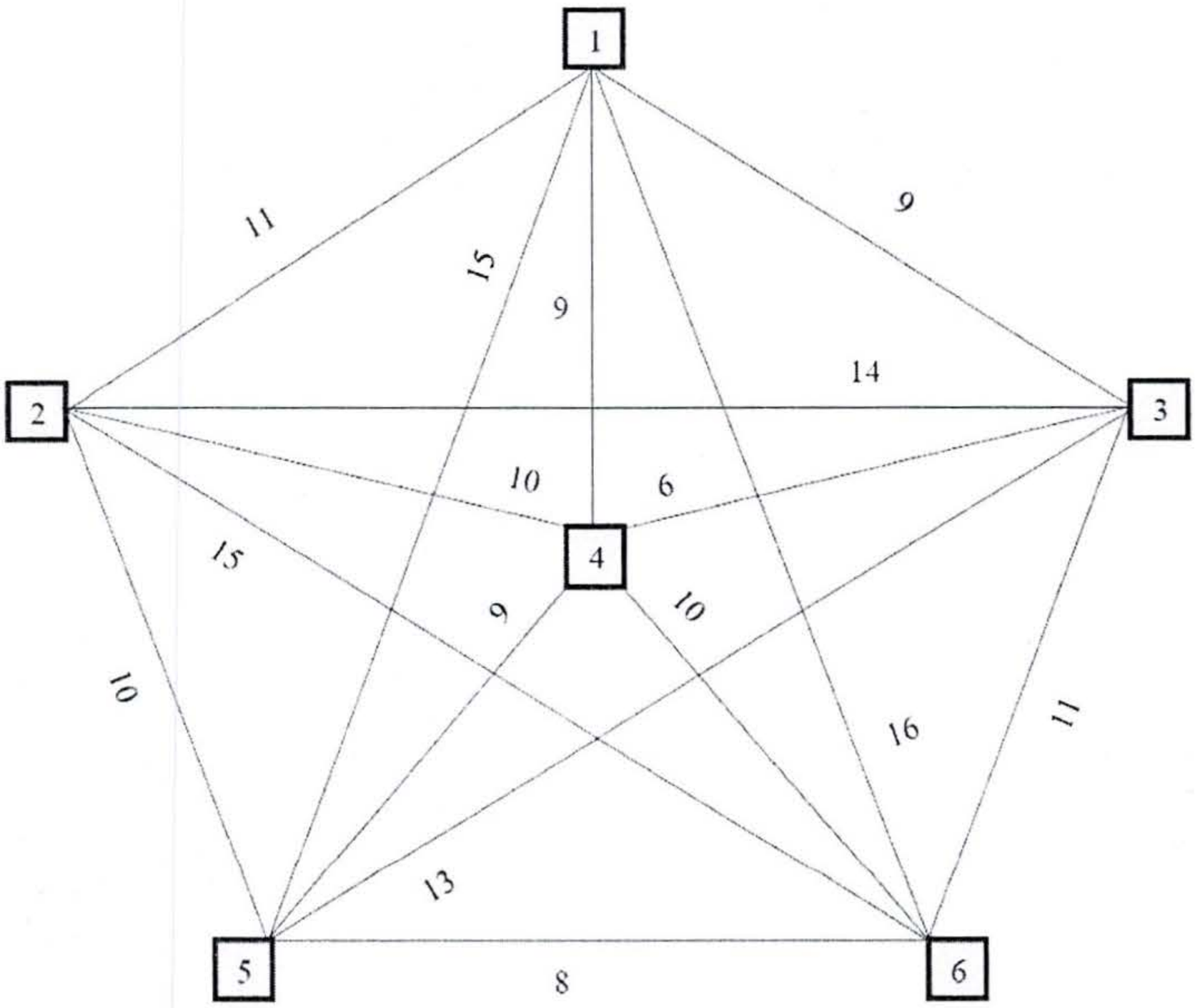

Figure 1: Travelling salesman network

A4. John Clooney, a bush pilot in Alaska, makes regular charter flights in his float plane to various towns and cities in western Alaska. His passengers include hunters, fishermen, backpackers and campers, and tradespeople hired for jobs in the different localities. He also carries some cargo for delivery. The following network shows the possible air routes between various towns and cities John might take (with the times, in hours). For safety reasons, he flies point-to-point, flying over at least one town along a route, even though he might not land there. In the upcoming week John has scheduled charter flights for Kotzebue, Nome, and Stebbins.

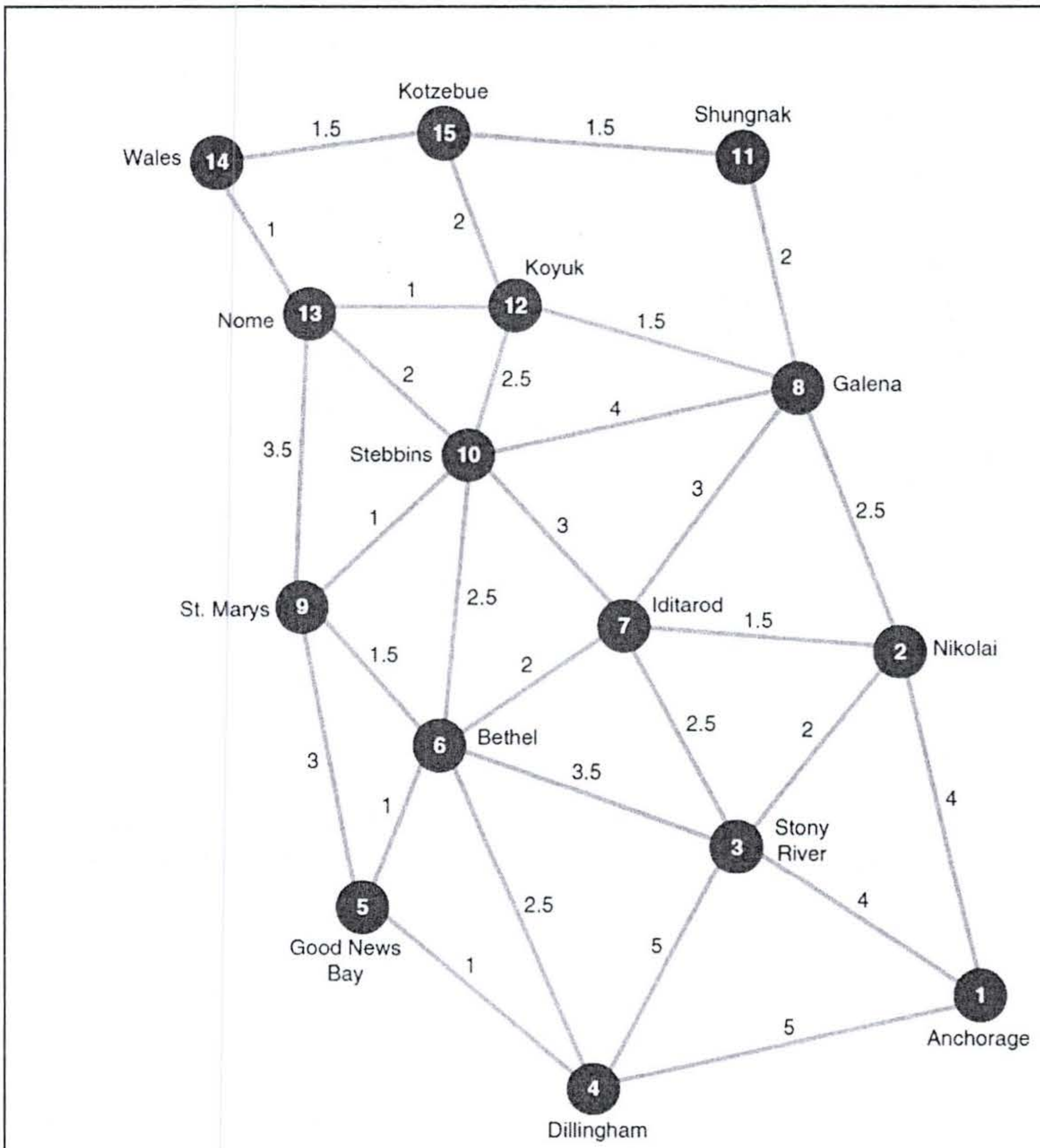

Figure 2: Transportation network

Use **Dijkstra's algorithm** to determine the shortest route between Johns home base in Anchorage and each of these destinations as shown in Figure 2 above. [10]

SECTION B: Answer any three questions in this section (60 marks).

B5. The Tell-All mobile-phone company services four geographical areas. The satellite distances (in miles) among the four areas are given in Figure 3. Tell-All needs to determine the most efficient message routes that should be established between each two areas in the network.

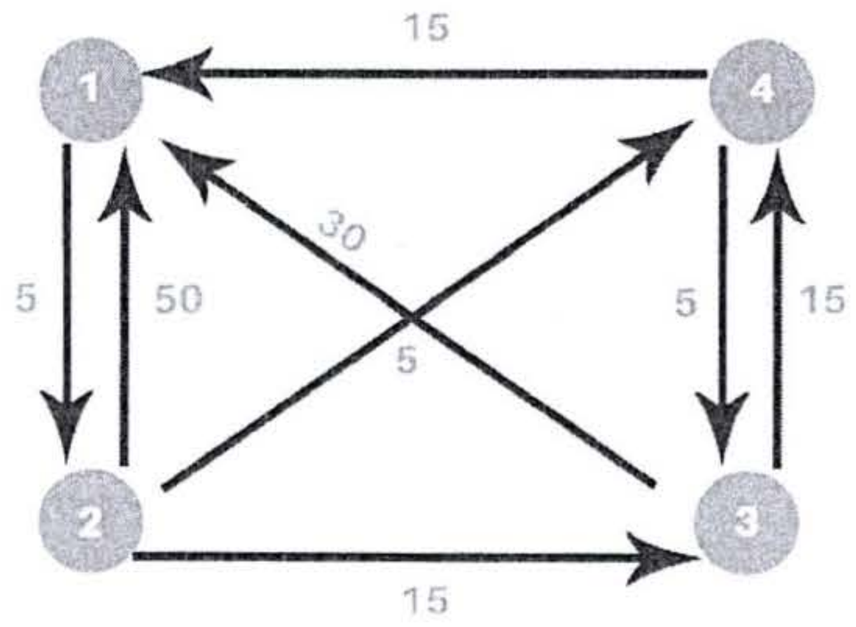

Figure 3: Directed network

(a) Use **Floyd-Warshall algorithm** to find all pairs shortest paths and respective distances in the network above. [20]

B6. State University has decided to reconstruct the sidewalks throughout the east side of its campus to provide wheelchair access. However, upgrading sidewalks is a very expensive undertaking, so for the first phase of this project, university administrators want to make sure they connect all buildings with wheelchair access with the minimum number of refurbished sidewalks possible. Following is a network of the existing sidewalks on the east side of campus, with the feet between each building shown on the branches:

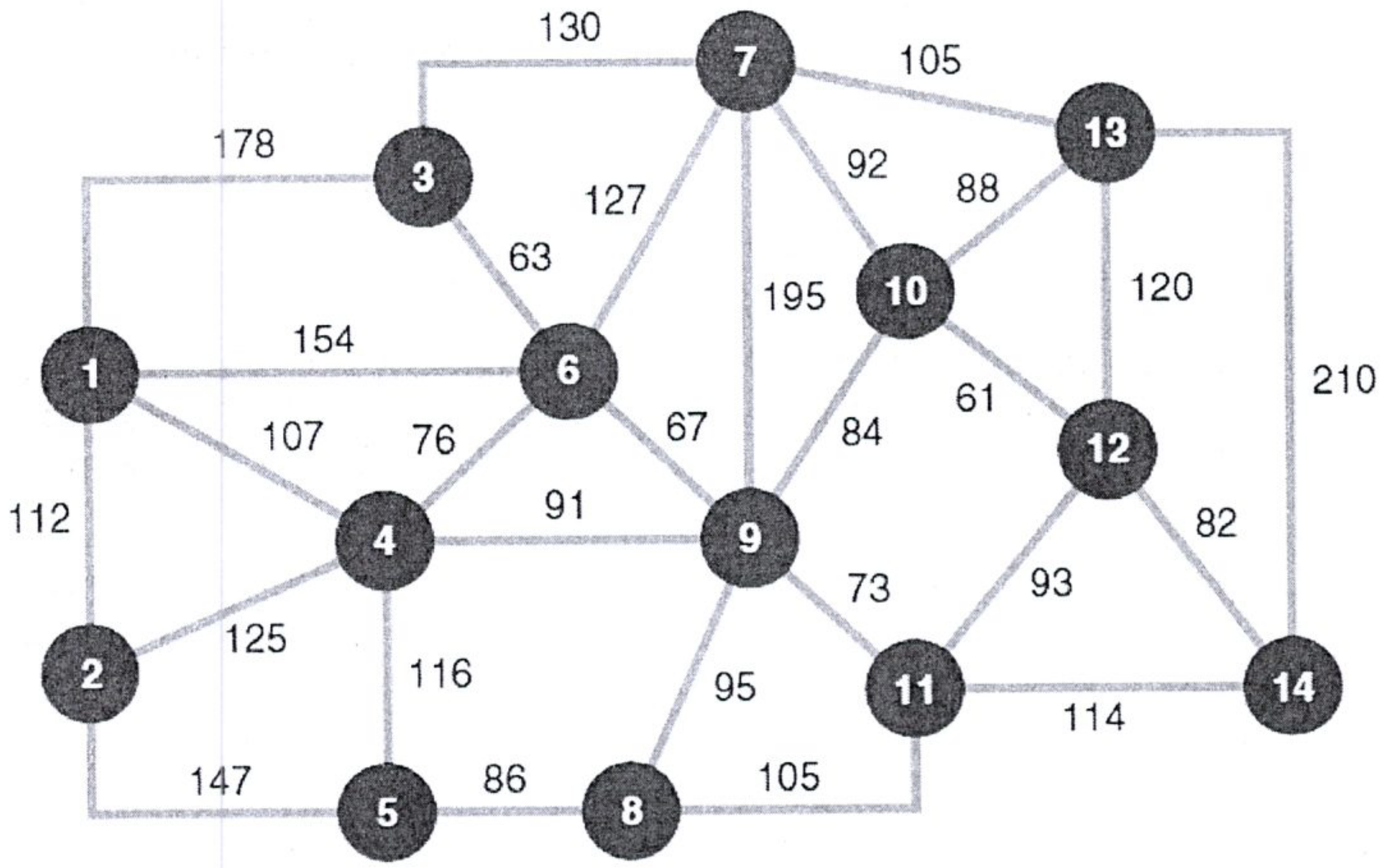

Figure 4: State university network

Apply **Kruskal's algorithm** to determine a minimal spanning tree network that will connect all the buildings on campus with wheelchair access sidewalks and indicate the number of feet of sidewalk [20].

B7. Figure 6 below shows a directed network with source node s, and sink node t. Use **Ford-fulkerson algorithm** to determine the maximum flow value. [20]

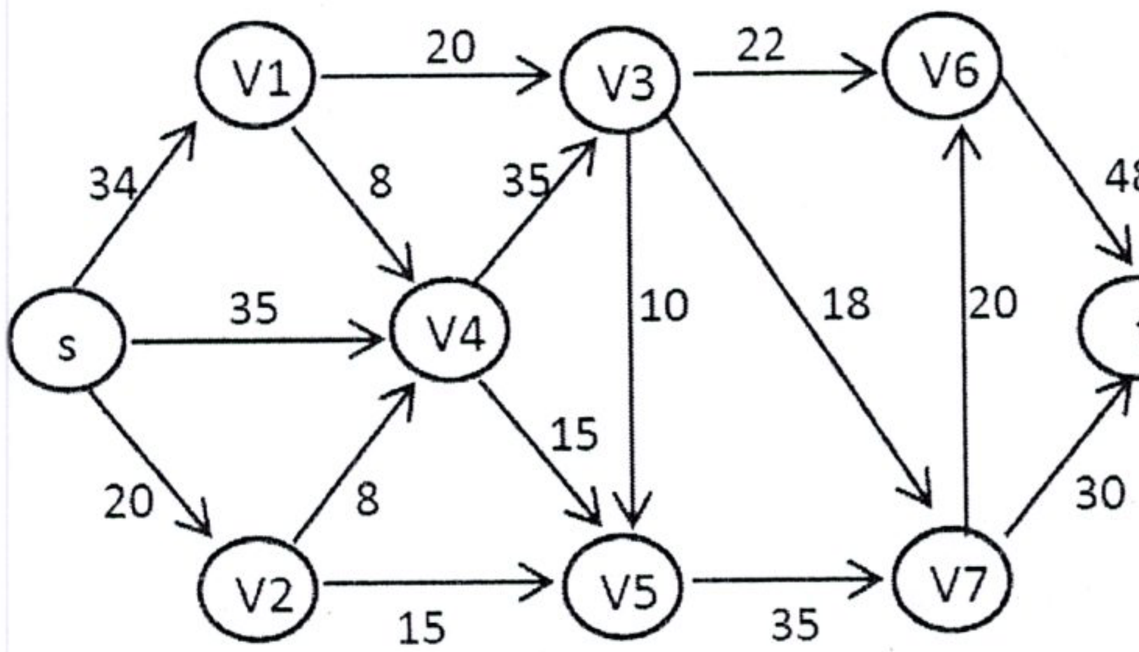

Figure 5: Pipeline network

B8. The Farmers American Bank of Leesburg is planning to install a new computerized accounts system. Bank management has determined the activities required to complete the project, the precedence relationships of the activities, and activity time estimates, as shown in the following figure 6.

Activity	Activity Description	Activity Predecessor	Time Estimates (weeks) *a*	*m*	*b*
a	Position recruiting	—	5	8	17
b	System development	—	3	12	15
c	System training	a	4	7	10
d	Equipment training	a	5	8	23
e	Manual system test	b, c	1	1	1
f	Preliminary system changeover	b, c	1	4	13
g	Computer–personnel interface	d, e	3	6	9
h	Equipment modification	d, e	1	2.5	7
i	Equipment testing	h	1	1	1
j	System debugging and installation	f, g	2	2	2
k	Equipment changeover	g, i	5	8	11

Figure 6: Project activities

Determine the expected project completion time and variance and determine the probability that the project will be completed in 40 weeks or less. [20]

END OF QUESTION PAPER