EE5134 – Optical Communications and Networks
CA 1 – Assignment (Sem 2, AY 2022-2023)
Lecturer: Assoc. Prof. Mohan Gurusamy

Instructions:

1. Answer all FOUR Questions.
2. Q1, Q2, Q3, and Q4 carries 15, 10, 10, and 5 marks, respectively.
3. Answers shall preferably be type-written using Word, Latex or any other documentation software of your choice to prepare the report as a PDF document.
4. Name the report as <Student_no-EE5134-CA1> and submit the PDF document it to the folder "CA1 Reports" under "Assignments" at Canvas.
5. The submission is due by 11-59 pm on Sunday 13th March 2022. No extension will be given.
6. The answers must be yours and in your own words. Our university views any form of cheating and plagiarism (like copying from other students or reports or web sources) very seriously. The penalty for indulging such an act could be as severe as termination of your candidature or award of F grade in the module.

---

1. Consider a variant of the HLDA algorithm which works as follows. Instead of subtracting the next highest value whenever a lightpath is established between a node-pair, it subtracts a fixed value of 0.1. Consider a WDM network and the normalized traffic demand between node-pairs as shown in the figure and Table 1, respectively. Assume that there are two wavelengths w_0 and w_1 per fiber and each node is equipped with two transmitters and two receivers.

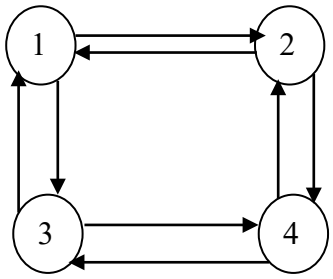


Table 1

Nodes	1	2	3	4
1	0	0.78	0.8	1.00
2	0.75	0	0.8	0.70
3	0.32	0.72	0	0.60
4	0.65	0.64	0.55	0

a) Design a virtual topology using the above algorithm. For each iteration of the algorithm, list the node-pair considered and the physical route and wavelength chosen to establish the lightpath. Give the reason if a lightpath cannot be established. For a node-pair, choose the shortest physical route which is free. If more than one route with the same number of hops are free, choose the one which has higher number of free wavelengths; if all the free paths have the same number of free wavelengths then choose the one which traverses in the clockwise direction. Use a fixed-order wavelength assignment method which chooses the wavelength with the lowest index among the free wavelengths. Give your answer in the format as in Table 2 below.

b) Suppose traffic flows are routed between every node pair with the load as specified in the traffic demand matrix in Table 1. Each traffic flow is routed between each node pair over the virtual topology on the shortest path. For each node pair, give the path used for traffic routing. Give your answer in the format as in Table 3 below. Compute load on each lightpath and tabulate it in Table 4.

c) Calculate the average weighted number of (virtual) hops and congestion.

Table 2:

Iteration	Node pair	Physical path	Wavelength	Remarks

Table 3

Traffic flow <s,d>	Route on virtual topology	No. of (virtual) hops

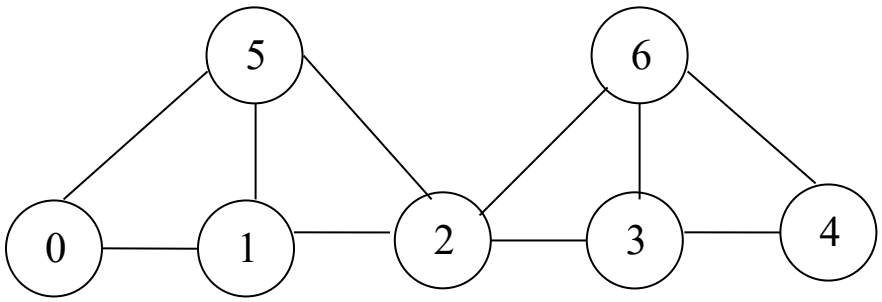
Table 4

Lightpath i→j	Load

(15 marks)

2. Consider a WDM network with 4 wavelengths per fiber as shown in Figure below. The wavelengths are labeled w_0 through w_3. The mean time to failure (MTTF) and mean time to repair (MTTR) of each link in the network are 9 and 1 unit, respectively. The MTTF and MTTR values are assumed to be independent for the links. Suppose that node 2 is provided with wavelength converters. The wavelength availability on different links is as stated in the table below.

Link	Wavelength availability
0-1	w_0, w_1, w_2
0-5	w_1, w_3
1-2	w_0, w_1
1-5	w_0
2-3	w_1, w_2
2-5	w_2
2-6	w_2
3-4	w_1, w_3
3-6	w_1
4-6	w_0, w_2



(a) Calculate the availability of a link

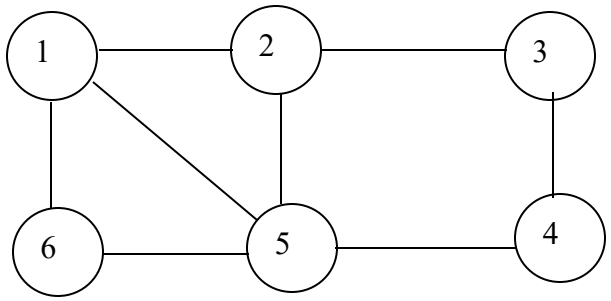
(b) Which path and wavelength are chosen if it is required to set up a lightpath from node 0 to node 4 without requiring any wavelength conversion?

(c) What is the availability value for the path chosen in part Q2(b)?

(d) It is possible to improve the availability of a path by protecting one or more links, or segments on a path. What are the links and/or segments that can be protected on the path chosen in part Q2(b) to improve the path availability?. For each possible case of such protection, calculate the improved availability value. The wavelength converter can be used, if needed, for protection purpose.

(10 marks)

3. Consider the following WDM network with 6 nodes and two wavelengths per fiber. Assume that the traffic demand is dynamic. Assume that two link-disjoint shortest paths are used for a node-pair to provide path protection. Give an example to illustrate (i) dedicated backup and (ii) shared backup methods. Choose three node pairs such that only two can be protected by the dedicated backup method while all the three can be protected by the shared backup method. Give your answer in the form of a table with four fields, <s,d>, <primary path, wavelength>, <backup path, wavelength>, <accept/reject, reason>



(10 marks)

4. A burst scheduling algorithm called Most Used Channel First (MUCF) chooses the wavelength channel on which most bursts are currently active among the possible wavelength channels for a new burst. Show with an example that MUCF performs poorly when compared to the Latest Available Unscheduled Channel (LAUC) scheduling algorithm. In your example, choose a burst-switching node with 2 wavelengths w_0 and w_1 per fiber and five bursts. Your example should be such that MUCF can schedule B1 to B4, but not B5, whereas, LAUC can schedule all the bursts B1-B5. Give your answer pictorially.

(5 marks)

END OF PAPER