EE5134-Optical Communication and Networks

CA1 – Assignment

March 17, 2023

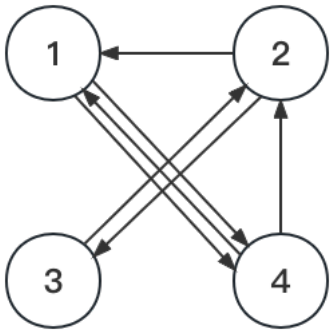
Question 1

(a)

The trace of the algorithm is given below.

Iteration	Node Pair	Physical Path	Wavelength	Remarks
1	1,4	$1 \rightarrow 2 \rightarrow 4$	w_0	clockwise
2	1,4	$1 \rightarrow 3 \rightarrow 4$	w_0	more free wavelength
3	1,4	N/A	N/A	Node 1 no Tx
4	2,3	$2 \rightarrow 4 \rightarrow 3$	w_1	clockwise
5	1,3	N/A	N/A	Node 1 no Tx
6	1,2	N/A	N/A	Node 1 no Tx
7	2,1	$2 \rightarrow 1$	w_0	
8	3,2	$3 \rightarrow 1 \rightarrow 2$	w_1	clockwise
9	2,3	N/A	N/A	Node 2 no Tx
10	2,4	N/A	N/A	No free wavelength
11	4,1	$4 \rightarrow 3 \rightarrow 1$	w_0	clockwise
12	2,1	N/A	N/A	Node 1 no Rx
13	4,2	$4 \rightarrow 2$	w_0	
14	3,2	N/A	N/A	No free wavelength
15	3,4	N/A	N/A	Node 4 no Rx
16	4,3	N/A	N/A	No free wavelength
17	4,1	N/A	N/A	No free wavelength
18	3,1	N/A	N/A	No free wavelength

The virtual topology is shown in the following figure:



(b)

Traffic flow <s,d>	Route on virtual topology	No. of (virtual) hops
<1,2>	1-4-2	2

<2,1>	2-1	1
<1,3>	1-4-2-3	3
<3,1>	3-2-1	2
<1,4>	1-4	1
<4,1>	4-1	1
<2,3>	2-3	1
<3,2>	3-2	1
<2,4>	2-1-4	2
<4,2>	4-2	1
<3,4>	3-2-1-4	3
<4,3>	4-2-3	2

Lightpath $i \rightarrow j$	Load
$1 \rightarrow 4$	0.78+0.8+1+0.7+0.6 = 3.88
$4 \rightarrow 1$	0.65
$2 \rightarrow 1$	0.75+0.32+0.7+0.6 = 2.37
$4 \rightarrow 2$	0.78+0.8+0.64+0.55 = 2.77
$2 \rightarrow 3$	0.8+0.8+0.55 = 2.15
$3 \rightarrow 2$	0.32+0.72+0.6 = 1.64

(c)

Average weighted number of hops:

$$h_{ave} = \frac{\sum(h_{s,d} \times t^{s,d})}{\sum t^{s,d}} = \frac{13.46}{8.31} = 1.6197$$

Congestion:

$$f_{max} = max f_{i,j} = max(3.88, 2.37, 2.15, 1.64, 0.65, 2.77) = 3.88$$

Question 2

(a)

Availability is the probability that a system will work as required when required during the period of a mission:

$$Availability = \frac{MTTF}{MTBF} = \frac{MTTF}{MTTF + MTTR} = 90\%$$

where MTTF = Mean Time To Failure, MTTR = Mean Time To Repair, MTBF = Mean Time Between failure = MTTF + MTTR.

(b)

if it is required to set up a lightpath from node 0 to node 4 without requiring any wavelength conversion, the path is $0 \rightarrow 1 \rightarrow 2 \rightarrow 3 \rightarrow 4$ with wavelength w_1

(c)

For path $0 \rightarrow 1 \rightarrow 2 \rightarrow 3 \rightarrow 4$ the availability is:

$$Availability = \left(\frac{9}{9+1}\right)^4 = 65.61\%$$

(d)

It is possible to improve the availability of a path by protecting one or more links, or segments on a path. Since it is given that only node 2 has converter, we can use the converter with protection path. Path $2 \rightarrow 3 \rightarrow 4\ (w_1)$ can be protected by path $2 \rightarrow 6 \rightarrow 4\ (w_2)$:

$$fail_{2,3,4} = 1 - (90\%)^2 = 19\%;$$
$$fail_{2,6,4} = 1 - (90\%)^2 = 19\%$$
$$fail_{both} = 19\% \times 19\% = 3.61\%$$
$$Availability\ =\ 1 - 3.61\%\ =\ 96.39\%$$

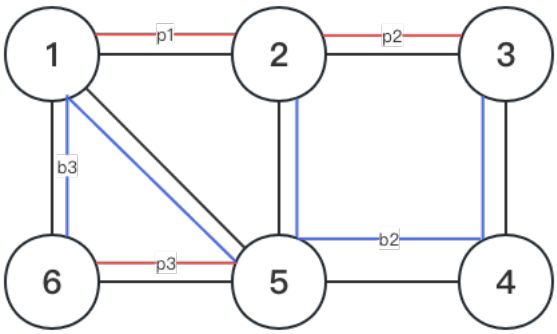
The overall improved availably is:

$$Availability_{0,2} \times Availability_{2,4} = (90\%)^2 \times 96.39\% = 78.08\%$$

Question 3

(i)

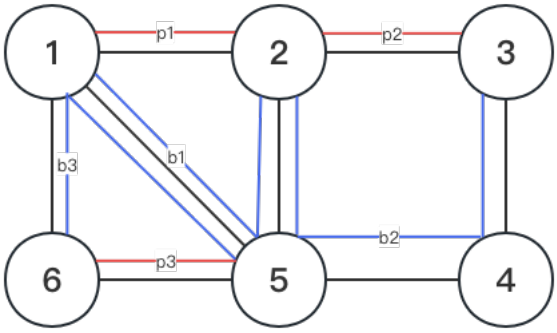
Dedicated backup figure:



<s,d>	<primary path, wavelength>	<backup path, wavelength>	<accept/reject, reason>
<1,2>	<1-2,w_0>	N/A	<**reject**, the backup path is occupied by b3 and b2>
<2,3>	<2-3,w_0>	<2-5-4-3, w_0>	<**accept,** do not need to share the path with others>
<6,5>	<6-5,w_0>	<6-1-5, w_0>	<**accept,** do not need to share the path with others>

(ii)

Shared backup figure:



<s,d>	<primary path, wavelength>	<backup path, wavelength>	<accept/reject, reason>
<1,2>	<1-2,w_0>	<1-5-2, w_1>	<**accept**, the backup path is shared with b3 and b2 in different wavelength>
<2,3>	<2-3,w_0>	<2-5-4-3, w_0>	<**accept,** share the path with b1>
<6,5>	<6-5,w_0>	<6-1-5, w_0>	<**accept,** share the path with b1>

Question 4