1. Bit stuffing

a)
Bit string before bit-stuffing = 100111111001010111100011 → 100111110100101111100011
After bit-stuffing = 100111110100101111100011

b)
Received bits before de-stuffing = 011111100011111011001111100110111111 0
01111110001111101100111111001101111110
After de-stuffing = 011111100011111110011111101101111110

2. Link Layer Protocols

Channel bit rate = 4Kb/s, Tprop = 20ms = 20E-3s
50% link utilization = 0.5 * 4Kb/s = 2Kb/s = 2*2^10 bits/s

2*2^10 bits/s =< frame_size / RTT
RTT = 2 * Tprop = 2 * 20E-3s = RTT = 40E-3s or 40ms (assuming transmission time of ack by receiver negligible)

2*20^10 bits/s =< frame_size/40E-3s → (2*2^10 bits/s)(40E-3s) =< frame_size
Therefore frame_size must be a least 81.92 → 82 bits for 50% utilization
100% utilization happens when frame_size = 4*2^10 bits/s *40E-3 s = 163.84 → 163 bits (round down b/c cannot exceed 100% utilization)

Therefore the range frame sizes to give at least 50% link utilization efficiency:
82 bits <= frame size <= 163 bits

3. Distance Vector Routing

C's new routing table after update from B,D and E

Destination	Cost	Route
A	11	C→B→A
B	6	C→B
C	0	C
D	3	C→D
E	5	C→E
F	8	C→B→F

4. TCP Sequence Numbers

Consider an optical fiber link that can run at 75 terabits/second (75 * 2^40 bits/s)
Consider TCP using 64 bit sequence numbers (2^64 sequence numbers total)
What is maximum packet lifetime to prevent sequence number wrap around?

1 sequence number = 1 byte
2^64 bytes / ((75 * 2^40) / 8) bytes/second = 1.789E6 seconds for byte (sequence number) lifetime = about 20.7 days

NOTE: below was done considering packets, I spoke to Prof Bletsch and he said just the answer above was needed but I included these anyway…

Assuming max packet size of 64KB:
Maximum packet lifetime = 1.789E6 seconds/byte / (64*2^10) bytes = 27.3 seconds

Assuming 1460 byte size packet (noted in lecture slides as common for fitting in 1 ethernet frame with IP and TCP headers):
Maximum packet lifetime = 1.789E6 seconds/byte / 1460 bytes = 1225.34 seconds

5. DNS

WHOIS LOOKUP

duke.edu is already registered*

Domain Name: DUKE.EDU
Registry Domain ID: 5059_DOMAIN_EDU-VRSN
Registrar WHOIS Server: whois.educause.net
Registrar URL: http://www.educause.edu/edudomain
Updated Date: 2017-06-03T07:03:56Z
Creation Date: 1986-06-02T04:00:00Z
Registry Expiry Date: 2018-06-02T04:00:00Z
Registrar: Educause
Registrar IANA ID: 365
Registrar Abuse Contact Email:
Registrar Abuse Contact Phone:
Domain Status: clientDeleteProhibited https://icann.org/epp#clientDeleteProhibited
Domain Status: clientTransferProhibited https://icann.org/epp#clientTransferProhibited
Domain Status: clientUpdateProhibited https://icann.org/epp#clientUpdateProhibited
Name Server: DNS-AUTH-01.OIT.DUKE.EDU
Name Server: DNS-AUTH-02.OIT.DUKE.EDU
Name Server: DNS-NC1-01.OIT.DUKE.EDU
DNSSEC: unsigned
URL of the ICANN Whois Inaccuracy Complaint Form: https://www.icann.org/wicf/
>>> Last update of whois database: 2018-02-19T14:50:51Z <<<

Date of domain registration: 1986-06-02T04:00:00Z (June 2nd, 1986)
Expiration date: 2018-06-02T04:00:00Z (June 2nd, 2018)
DNS Servers for duke.edu: DNS-AUTH-01.OIT.DUKE.EDU, DNS-AUTH-02.OIT.DUKE.EDU, DNS-NC1-01.OIT.DUKE.EDU

6. Internet Services

Displayed URL to console: