COLOGE OF ELECTRONIC TECHNOLOGY

SUBJECT: - Communications Systems | **DATE: - 23 - 07 - 2018**
COURSE NO. : - CM 404 | **Final Exam Solution**
~~**Fall 2017**~~ SPRING 2018 | **Time: 2 hours**

Student Name:-	Student Number:-

PART I CLOSED BOOK EXAM

Q1. a) What are the main involved steps in FDM multiplexing and FDM demultiplexing processes? *(5)*

In multiplexing; Mixing – Filtering – Combining.
In demultiplexing; Splitting – Filtering – Mixing – Filtering.

b) Why the output of TDM having three streams of 2.048 MBPS is not equal three times its input (3 × 2.048 MBPS = 6.144 MBPS) *(5)*

Because of two reasons;

i.) **2.048 MBPS is E1 standard in the "E" standard (European standard) and the next standard is E2 which have 4 E1 inputs .**
ii.) **In E standers there are some staffing bits for synchronization issue.**

c) What are the advantages and disadvantages of FHSS systems? *(5)*

Advantages; - Much larger bandwidth using frequency hopping than using direct-sequence, which can produce a significantly higher processing gain.
- Provide more immunity to certain types of channel distortion

Disadvantages; PM techniques such as PSK and DPSK are difficult to use because of problems maintaining phase coherence across frequency hops.

d) What are main three types of the overheads in SDH system? And where are they exist in the SDH frame? *(5)*

Regenerator Section Overhead; the first 9 bytes of the first 3 rows of the frame.
Multiplex Section Overhead; the first 9 bytes of the last 5 rows of the frame.
Path Overhead; the first bytes of each row of the virtual container.

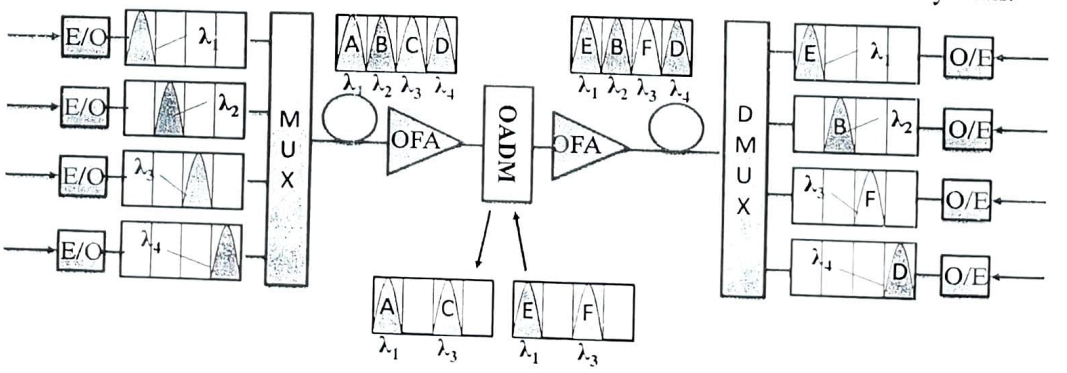
e) What are the main service of TETRA network? *(5)*

Individual call - Group call - Acknowledgment group call – Broadcast call.

f) Suppose *you have 806 - 821 MHz bandwidth for TETRA system, how many logical channels can obtained from this band?* *(5)*

For (821 – 806 = 15 MHz) band we have 7.5 MHz transceiver BW. And for 25 KHz radio carrier, we can get 7500/25 = 300 carriers. For 4 time slots per carrier, we get 1,200 time slots which are logical channels.

g) sketch a block diagram showing the main components of DWDM system? *(5)*



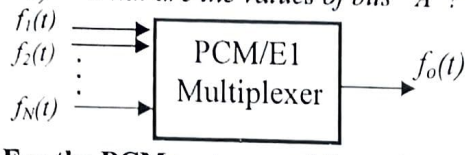
h) What is the main deferent between classical WDM and DWDM? *(5)*

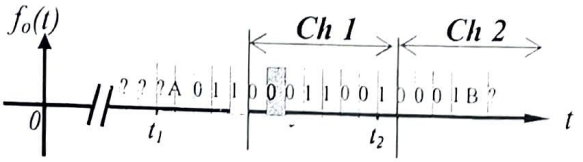
For the classical WDM systems a few wavelengths (mostly two) are transmitted. Where in the DWDM the number of transmitted wavelengths is much more than 2.

PART II OPEN BOOK EXAM

Q2. The given PCM/E1 multiplexer has "N" input signals. All the input were DC signals. The 1st signal -10V, the 2nd signal -9V, the 3rd signal -8V, and so on. The minimum voltage can be represented in the PCM modulator is -16 and has 0.25 V step size.
The $f_o(t.)$ shown below is part of the 6th frame of the output signal, and the shaded bit is representing the second bit in the time slot (the second MSB).

a) What are the values of bits "A"?





For the PCM system, and from the given data
-16V is level 0 ≡ 00000000, -10V is level 25 ≡ 00011001, -9V is level 29 ≡ 00011101,

Since the inputs are DC values, all values of ch_1 are -10V ≡ 00011001, and ch_2 are -9V ≡ 00011101, ch_3 are -8V≡ 00100001, and so on
Since the shaded bit is the 2nd bit in the time slot, so its value is 00011001.
So, it is the time slot for Ch_1 which is the 2nd time slot in the frame (frame 16 as given)
The bit "A" is the 5th bit in the 1st signaling slot of frame 16, which should be $C_1$0011011.
So the bit "A" is 1

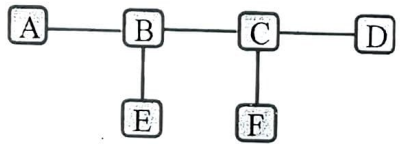
b) Find the time t_1? *(10)*

The time t_1 is the starting time of the 4th bit in the 1st time slot in frame 16.

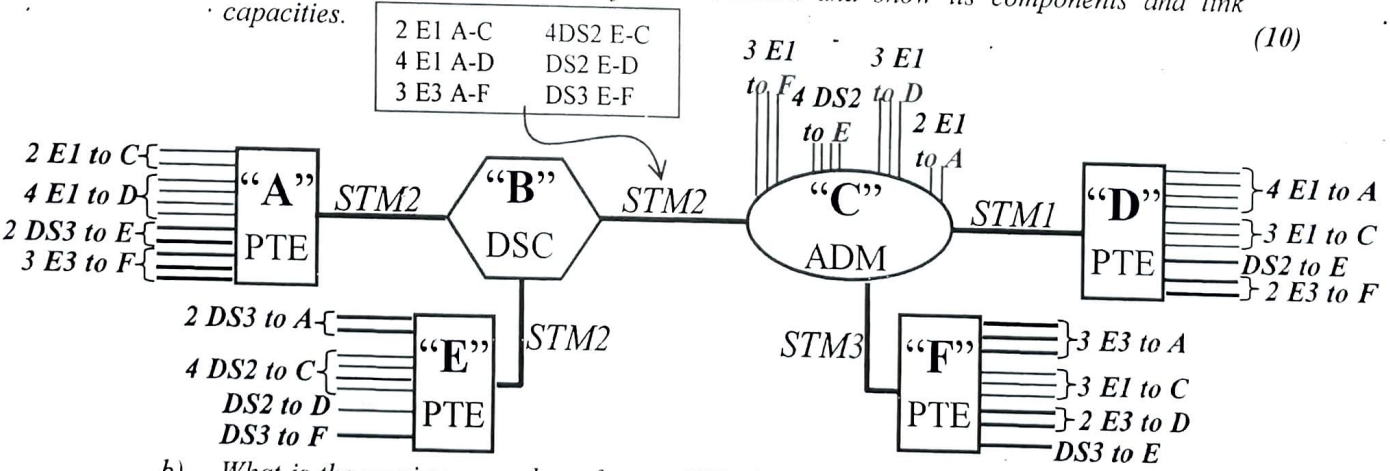
$$t_1 = 15 \times 125\ \mu s + 4 \times \frac{1}{2.048000} = 1876.953\ \mu s$$

Q3. A SDH network connecting six locations as show below. The carried traffic is given in the traffic table?

	C	D	E	F
A	2 E1	4 E1	2 DS3	3 E3
C		3 E1	4 DS2	3 E1
D			DS2	2 E3
E				DS3



a) Propose the best configuration for the network and show its components and link capacities. *(10)*



b) What is the maximum number of extra E1's that can be carried between "A" and "F" without any expansion in network capacity. *(10)*

To go from A to F we should check the links A-B, B-C, and C-F

Link	Capacity	Traffic	Extra Possible E1
A – B	STM1	6 E1, 3 E3, and 2 DS3	5×3 = 15 E1
B – C	SEM2	6 E1, 5 DS2, 3 E3	7×3 = 23 E1
C – F	STM3	3 E1, 5 E3, and 1 DS3	6×3 + 2×7×3 = 60 E1

So, Only 15 extra E1's can be go from A to F without any expansion in network capacity

Good luck for every body

Dr. T. Benmusa

COLOGE OF ELECTRONIC TECHNOLOGY

SUBJECT: - Communications Systems
COURSE NO. : - CM 404
Spring 2018

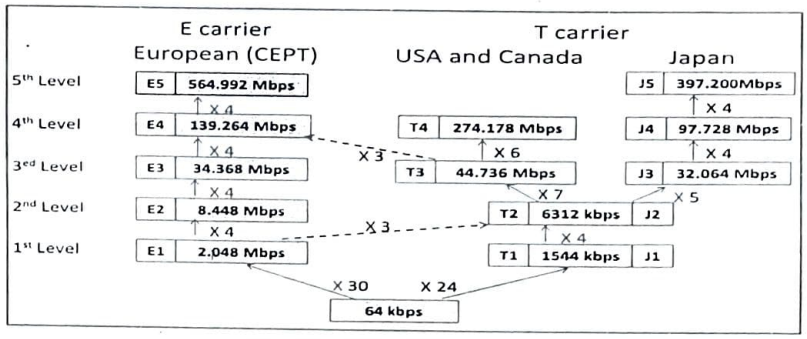
DATE: - 20 - 5 - 2018
Midterm Exam 1 Solution
Time: 2 hours

Q1 a) What is the main concept of TDM? **(5)**

The main concept of TDM is making the sample pulses narrower and the space that are left between pulses are used for pulses from other signals.

b) What are the standards for PDH systems? State the hierarchy for each of them. **(5)**

The two PDH standard are the E carrier (European system) and T carrier (North America System).

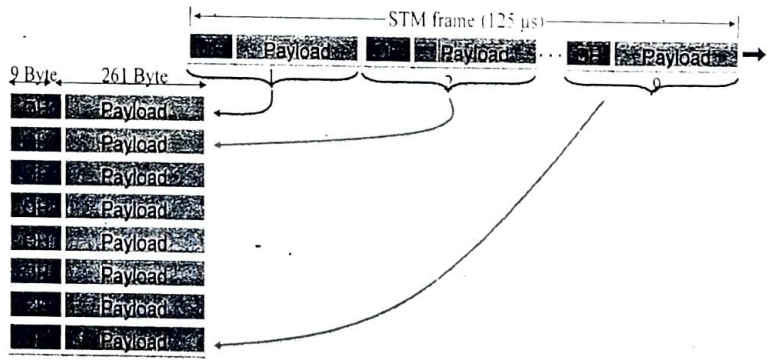


c) What is meant by Justification bits ? Justification control bits? **(5)**

Justification bits is additional bits are add in order to avoid of the slip of bits due to the small difference in the clock rates of the PDH input streams.
Justification control bits tells the system whether there are a justification bits or not, , their type (positive or negative), number of bits for each input.

d) Explain briefly the structure of the SDH frame? **(5)**

The STM-1 frame has 155.52 MBPS, and 125 µs
The Frame is made up of a "Section Overhead" field and a "Payload" field.
The frame represented as 9 Rows by 270 Columns for total of 2430 Bytes.
The first 9 Columns for Over Head and the other 261 columns are Payload



e) What are the main advantages of DSSS? **(5)**

Security - Low interference - No need for synchronization – And access control.

f) Discuss the limitations that prevent using the total DWDM wavelength? **(5)**

The lower limit is 1280 nm, which is limited by core diameter
The upper limit is 1650 nm, which is limited by attenuation.

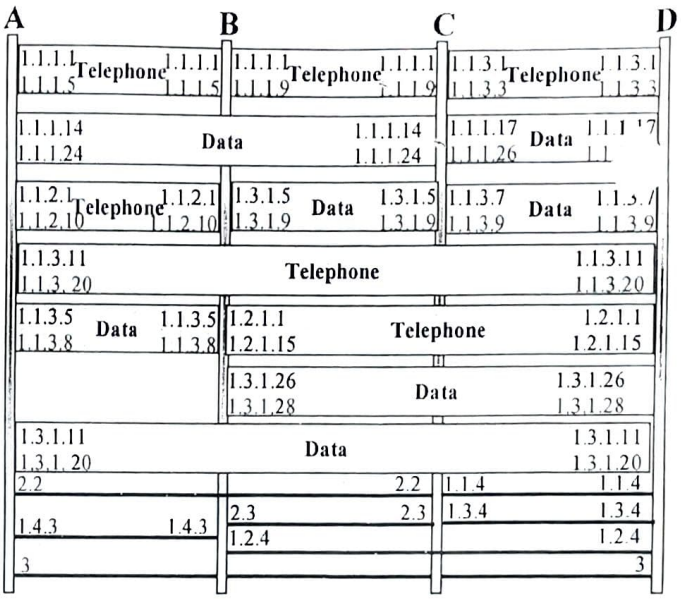
g) Can the code "111011100010010" be a valid PN sequence code for DSSS? **(10)**

Balance (satisfy): The code has eight "1"s and seven "0"s. Balance is achieved.
Run property(satisfy): The code has one two-bit run of "0"s and no two-bit run of "1"s.

2 three-bit runs of "1"s and one three-bit run of "0"s; satisfying the run property.

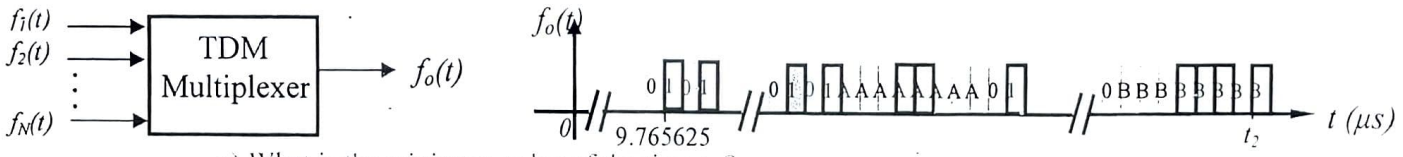
Correlation(unsatsfy)	[b] ⊙ [c] (1) 111011100010010 ⊙ 011101110001001 balance 100110010011011	[b] ⊙ [c] (2) 111011100010010 ⊙ 101110111000100 balance 010101011010110
	[b] ⊙ [c] (3) 111011100010010 ⊙ 010111011100010 balance 101100111110000	[b] ⊙ [c] (3) 111011100010010 ⊙ 001011101110001 unbalance 110000001100011

Q2. For the given multiplexer plan, if the telephone cards are serving 6 channels and data serve 5 channels. Give the bill of quantity for the main MUX equipment at station "C". (*15 marks*)



Description	Qty
Data Signaling card	4 + 3 = 7
Telephone Signaling card	2 + 1 = 3
E1 / 64KBPS MUX	3+3=6
E2 / E1 Mux (8M / 2M)	2 + 2 = 4
E3 / E2 Mux (34M / 8M)	2 + 1 = 3
E4 / E3 Mux (140M / 34M)	1 + 1 = 2

Q3. The given TDM multiplexer is one of the first order PDH MUX, has "*N*" input signals. The output signal was represented by $f_o(t)$ below. If the shaded bit is representing the 190th bit of non data bits, and the A's bits and B's bits are belongs to the same input channel;



a) What is the minimum value of the time t_2 ?

Since the multiplexer is one of the first order PDH so, it is either E1 or T1. But the time 9.765625 μs is a starting time of a bit in the output stream so, multiplying this no by the bite rate should be an integer.

Trying T1; 9.765625 μs × 1.544 MBPS = 15.078 not valid since the result is not integer.

Trying E1; 9.765625 μs × 2.048 MBPS = 20, It is integer, the system is E1. (*5 marks*)

The shaded bit no. 190 non data bit $\Rightarrow \frac{190}{16} = 11.875 \Rightarrow$ it is in the 12th frame

$190 - 11 \times 16 = 14 \Rightarrow$ it is in the second non data slot (16th slot) in the 12th frame

$14 - 8 = 6 \Rightarrow$ it is the 6th bit in time slot 16. (*7.5 marks*)

The A's bits belongs to channel 16 (time slot 17) in the 12th frame

The minimum value of t_2 if B's bits comes in the next frame (frame 13)

The B's bits belongs to channel 16 (time slot 17) in the 13th frame

Before t_2 there are 12 frame, 16 time slots, and 7 bits

$$t_2 = 12 \times 125 + 16 \times \frac{125}{32} + 7 \times \frac{1}{2.048} = \boxed{\mathbf{1565.918\ \mu s}}$$ (*7.5 marks*)

b) Suggest another value for t_2 apart from your answer in part "a" above.

Other possible values of t_2 if B's bits comes in frames above the 13th frame

So B's bits can be belongs to channel 16 (time slot 17) in the 14th frame

$$t_2 = 13 \times 125 + 16 \times \frac{125}{32} + 7 \times \frac{1}{2.048} = \boxed{\mathbf{1690.918\ \mu s}}$$ (*10 marks*)

Q4. STM1 SDH multiplexer carrying seven streams of T1 and can carry up to 29 streams of E1.

a) How many streams of T2 can carry?

The 29 streams of E1 can accommodate only $\left\lfloor \frac{29}{3} \right\rfloor$ = 9 streams of T2 (*7.5 marks*)

b) How many streams of T1 can carry?

The 29 streams of E1 can accommodate only $\left\lfloor \frac{29}{3} \right\rfloor \times 4$ = 36 streams of T1

The seven T1 streams are carried through two TUG-2. The first one is fully occupied and there is a space for another stream of T1 in the second one.

So the total no. of possible T1 streams can be carried is 36 + 1 = **37 streams** (*7.5 marks*)

Good luck for every body

Dr. T. Benmusa

Student S.N.

COLOGE OF ELECTRONIC TECHNOLOGY

SUBJECT: - Communications Systems | **DATE: - 20 - 12 - 2017**
COURSE NO. : - CM 404 | **Midterm Exam 1 Solution**
Fall 2017 | **Time: 2 hours**

Student Name:-	Student Number:-

PART I CLOSED BOOK EXAM

Q1. a) What is the bite rat for the pure data in E1 caring different voice frequency channels? (5)

30 × 8 × 8000 = 1,920,000 BPS = 1.92 MBPS.

b) Explain briefly the function of the Justification bits? (5)

Justification bits is an additional bits add in PDH multiplexer in order to avoid of the slip of bits due to the small difference in the clock rates of the input streams.

c) Why there is no difference in quantization noises of samples in T1 and E1 systems, even though the sample of E1 system represented by 8 bits and the sample of T1 system represented by 7 bits? (5)

Because both of them use 8 bits to represent a sample. But in T1 system the LSB is ignored and replaced by signaling and synchronization bit.

d) Give one case that SDH is not preferable, and give your reason. (5)

- **Low capacity systems**. Because it is very expensive.
- The required traffic does not require .

e) Can the following code be a PN sequence cod? And why? 1011100111010000 (5)

No because the run property dose not fulfill. (Two 3 ones and no 3 zeros).

f) What is the function of the Add/Drop Multiplexer in SDH systems? (5)

The Add/Drop MUX has the ability to breakout and insert low speed channels into an STM stream?

g) What are the advantages of DSSS systems? the answer without explanations. (5)

Security - No need for synchronization - Low interference - No need for access control.

h) Why we have to move from TDM to WDM at very high bit rate? (5)

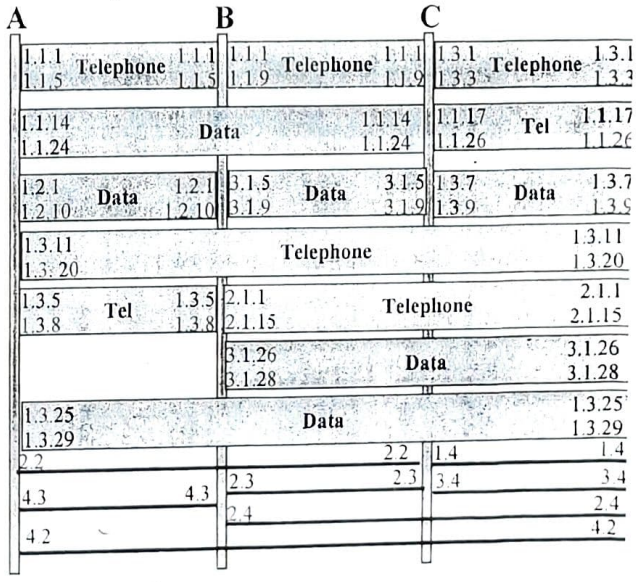
- **The required electronics are very difficult and quite expensive.**
- **The dispersion properties at high bandwidth can hardly be fulfilled.**

Q2. For the given multiplexer plan, if the telephone cards are serving 6 channels and data serve 4 channels.

a) *How many tel and data cahnnels can be added between A and D in the third 2 MBPS in the first 8MBPS of the system with and without adding channel cards?* (10)

2 tel and 0 data without adding cards and 12 channels by adding cards

E1 stream	Type	A	MUX	D
1.3	Telephone	4	7	5
	Data	3		0

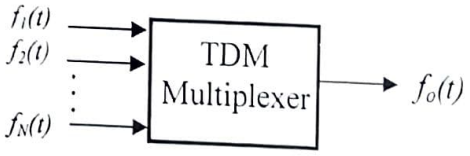


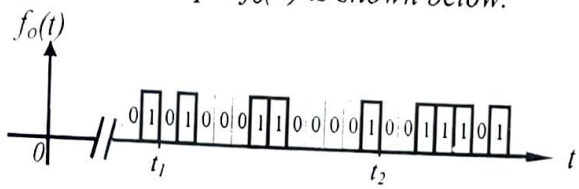
b) *How many E1 MUX at station B towards A, station B towards C, station C towards B, and at station C towards D?* **(10)**

Location	No. of E1 MUX's
at station B towards A	3 (1.1 - 1.2 - 1.3)
at station B towards C	4 (1.1 – 2.1 - 1.3 - 3.1)

Location	No. of E1 MUX's
at station C towards B	3 (1.1 - 1.3 - 3.1)
at station C towards D	3 (1.1 - 1.3 - 3.1)

Q3. *The given TDM multiplexer has "N" input signals. The output $f_o(t.)$ is shown below.*





a) *If t_1 = 118.3712 μs, and t_2 = 119.7917 μs. What is the maximum number of "N"?*

$T_b = \frac{119.79-118.37}{12} = 0.118375\ \mu s \Rightarrow R = \frac{1}{T_b} = 8.448$ MBPS ≡ (E2 stream) **(5)**

So maximum input is 4 × 30 × PCM signal (64 kbps) = 120 inputs **(5)**

b) *If t_1 = 42,039.61 ns, and t_2 = 42,116.77 ns. What is the starting time of the first data bit in the given figure?*

$T_b = \frac{42{,}116.77-42{,}039.61\ ns}{12} = 6.43\ ns \Rightarrow R = \frac{1}{T_b} = 0.1552$ GBPS = 155.52 MBPs

So, the system is SDH with capacity STM1 **(6)**

To find the order of the bit starts at t_1 we divide t_1 by T_b or multiplying by 0.15552 GBPs.

So, the order of the bit starts at t_1 = 42,039.61 ns × 0.15552 GBPs = 6,538

To know in which byte we divide by 8;

6,538 ÷ 8 = 817.25. That is mean there 817 byte and (0.25 × 8 = 2 bits) before t_1

So it is the starting time of the 3rd bit of the 818th byte

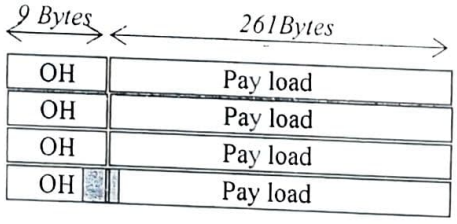
To know in which row we divide by 270;

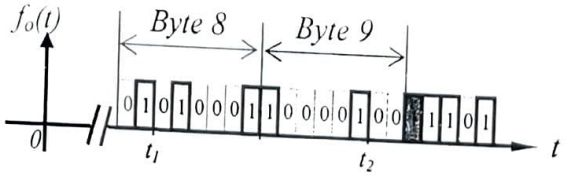
817 ÷ 270 = 3.026. That is mean there 3 rows, (0.26 × 270 = 7 byte), and 2 bits before t_1

So it is the starting time of the 3rd bit of the 8th byte in the 4th row. **(7)**

Since the first data bit in each row come in the first bit of the 10th byte. So, it should come after one byte and 6bits after t_1 as shown.

Its starting time is (270 × 3 × 8 + 9 × 8) ÷ 0.15552 = 6552 ÷ 0.15552 = 42,129.63 ns . **(7)**





Good luck for every body

Dr. T. Benmusa

COLOGE OF ELECTRONIC TECHNOLOGY

SUBJECT: - Communications Systems	DATE:- 06 – 07 - 2017
COURSE NO. : - CM 407	Final Exam Solution
Spring 2017	Time: 2 hours
Student Name:-	Student Number:-

PART I CLOSED BOOK EXAM

Q1 a) What is the used carrier frequency of the fifth channel while generating a group? *(5)*

f_{c4} = **108 kHz – 5 × 4 kHz = 88 kHz**

b) What is meant by drop / insert MUX station? *(5)*

Drop / insert MUX station; is a MUX station occurs in the middle of stations where received signal from one end is demultiplexed, some channels are dropped to that station. The rest channels are combined with other new channels generated from the station and multiplexed again before feeding to the transmitter of the other end.

c) What is the type (data bit or Overhead bit) of the 3500th bit in STM1 stream? *(5)*

$\frac{3500}{8} = 437.5$; **So, the 3500th bit is the 4th bit (0.5 ×8) in the 438th byte**

$\frac{438}{270} = 1.616$ **So, the 438th byte is the 168th byte (0.616 ×271) in the 2nd row**

And it is the 159th data byte (168 – 9)

d) How can we get multi hop HF transmission? *(5)*

By making the reflected wave from the ionosphere come on a smooth surface area such as water (see, ocean), desert.

e) A service of TETRA network allows some members call specific subscribers after their approval. What do we call this service? Also state whether is it simplex, semi-duplex, or full duplex mode? *(5)*

We call it acknowledgment group call. It is semi-duplex mode.

f) State two advantages and one disadvantage of the FHSS? *(5)*

Advantages, Higher process gain – higher immunity to frequency selective fading.

Disadvantages, difficult to maintain phase coherence across frequency hopping.

g) Why we are using the ATPC in the receiver of DMR radio to increase and decrease the transmitter power level ? *(5)*

Advantages, Higher process gain – higher immunity to frequency selective fading.
Disadvantages, difficult to maintain phase coherence across frequency hopping.

h) What is meant by spectral efficiency? Do we aim to get high or low value? And why? *(5)*

Spectral efficiency means how many data speed in bit /s can be carried in one hertz.
We aim to get higher value to send higher bite rate in small bandwidth.

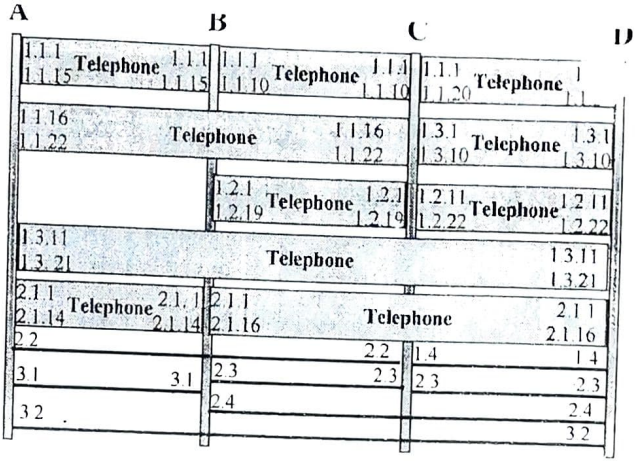
PART II OPEN BOOK EXAM

Q5. For the given multiplexer plan, if the telephone cards are serving 5 channels.

a) How many 2MBPS streams can be added between B - D and A - C, without any additional hard ware? *(5)*

Nothing between A and C,
Only one streams of 2MBPS can be added between "B" and "D" (1.4)

b) if we need to add another 22 channel; 15 channels of them between B and D, and another 7 Channels between A and D. What are the needed hard ware? *(15)*



	A	MUX	D
1.1	3	8	0
1.3	4	9	4
2.1	1+5	14	4+0
	1 card		2 card

	B	MUX	D
1.1	0	8	0
1.2	1+5	8	3+5
2.1	4+10	14	4+10
	3 card		3 card

Q6. SDH multiplexer carrying one stream of 34 MBPS, eight streams of 6 MBPS, five streams of 2 MBPS, and five stream of 1.5 MBPS?

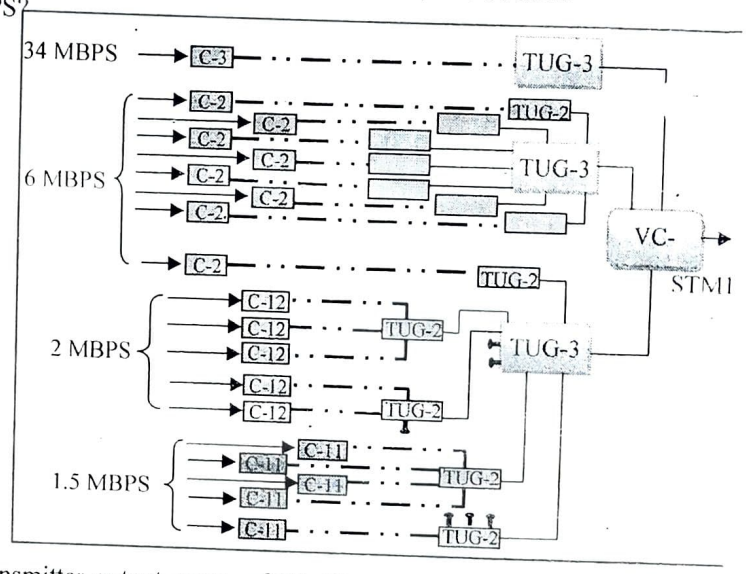
a) What is the maximum no. of E1 streams can be add to the system? *(15)*

The configuration should be as shown in the figure. We can add 7 streams of E1 as follows:

- **One streams of E1 (2 MBPS) directly to free TUG-2 inputs.**
- **2 free inputs of TUG-3each of them can accept 3 E1 streams.**

b) On the top of the capacity mentioned in part "a", how many extra DS1 streams can be add ? *(5)*

Three stream of DS1 can be added



Q7. A DMR link utilizing a radio with transmitter output power of 28 dBm, 2 dB equalizer improvement factor, and 4dB noise figure. The radio is next to 42.7 dB gain antenna. The link has the following specifications:

- The total free space loss is 141 dB.
- The target probability of errors for the two links is 10^{-9}. And the link reliability objective is 99.998%.
- The area has average train and worst case climate condition,
- The area considered as a heavy rain area and produces 0.4 db/km attenuation loss.

What is the minimum possible received signal power? *(5)*

For heavy rain condition and 0.4 dB/km attenuation, we can get the operating frequency from the rain attenuation vs frequency graph. SO F = 9 GHz

$L_s = 92.4 + 20 \log D_{km} + 20 \log F_{GHz} \Rightarrow 20 \log D_{km} = L_s - 92.4 - 20 \log F_{GHz}$

$D_m = 10^{\frac{L_s - 92.4 - 20 \log F_{GHZ}}{20}} = 10^{\frac{141 - 92.4 - 20 \log 9}{20}} = 10^{1.47} =$ **30 km**

Total rain attenuation $L_{rain} = \alpha_{rain} \times D_{km} = 0.4$ **dB/km** $\times$ **30 km =** **12 dB**

$P_{r\,min} = P_t + G_t + G_r - L_s - L_f - L_b - L_{rain} - L_{others} + EQIF$

$= 28$ dBm $+ 42.7$ dB $+ 42.7$ dB $- 141$ dB $- 0 - 0 - 12$ dB $- 0 + 2$dB $=$ **-37.6 dBm**

$FM = 30 \log D_{km} + 10 \log(6 A B F_{GHz}) - 10 \log(1 - R) - 70$

$= 30 \log 30 + 10 \log(6 \times 1 \times 1 \times 9) - 10 \log(1-0.99998) - 70 =$ **38.6 dB**

$FM = P_r - C_{min} \Rightarrow C_{min} = P_r - FM = -37.6$ dBm $- 38.6$ dB $=$ **-76.2 dBm**

Good luck for every body

Dr. T. Benmusa

COLOGE OF ELECTRONIC TECHNOLOGY

SUBJECT: - Communications Systems
COURSE NO. : - CM 407
Spring 2017

DATE:- 13 – 06 - 2017
Midterm Exam 2
Time: 1.5 hours

PART I CLOSED BOOK EXAM

Q1 What is meant by?

a) Full duplex operation mode? *(4)*

The two parties of the communication can send and receive at the same time.

b) 1 Erlang *(4)*

Is the traffic generated to occupy the communication link 60 minutes in 1 hour.

c) M + N standby configuration for microwave system? *(4)*

We have "M" links and "M" radios operational and another "N" radios standby can take over any minute in case of failure or any other reason.

d) 3 dB gain? *(4)*

Multiplying the power by factor two (doubling the power).

Q2. a) State general equation to find the power at DMR receiver. Define its parameters *(5)*

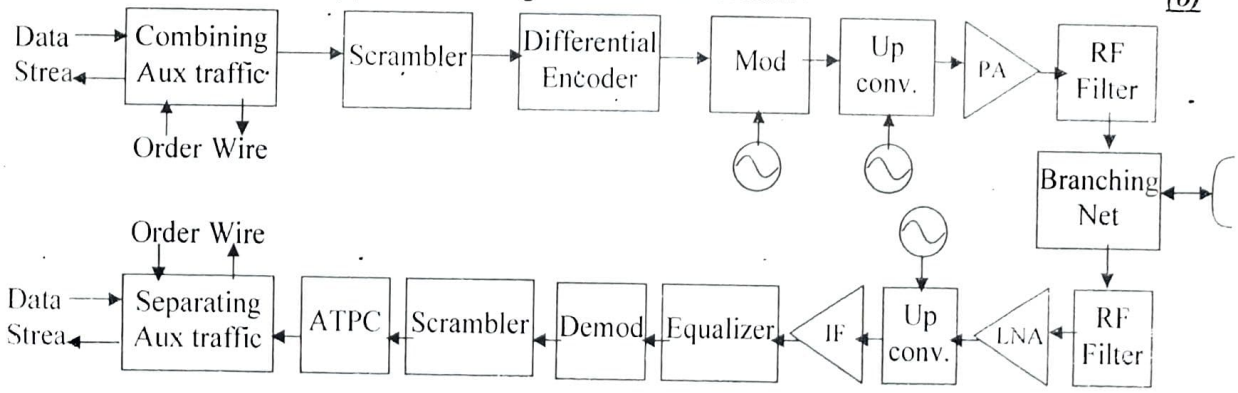
$P_r = P_t + G_t + G_r - L_s - L_{ft} - L_{fr} - L_b - L_{rain} - L_{others} + AEQIF$

P_t: Transmit power
$AEQIF$: Adaptive equalizer Improvement factor
G_t, G_r gain of transmitter and recover antennas
L_s: *Free space loss*
L_b: *Branching* loss
L_{ft} /L_{fr} : *TX/RX* Feeder loss

b) what is the multiple access technique used in TETRA system? Give numerical values. *(6)*

FDMA (has several RF carrier with 25 kh BW. And TDMA where each carrier has 4 time slots.

c) Sketch a typical block diagram for the DMR radio? *(6)*



b) State the main four Atmospheric Effects on Free Space propagation. How they are varying with frequency? *(6)*

EFFECTS	VARYING WITH FREQUENCY
Atmospheric Absorption	Negligible for < 10 GHZ
Scattering Due to Rain or Fog	For light rain; Negligible for < 10 GHZ For heavy rain; Negligible for < 6 GHZ
Atmospheric Refraction	Does not change
Diffraction Effects (The Fresnel Zone)	Decrease by increasing the frequency

PART II OPEN BOOK EXAM

Q3. A TETRA network serving 200 subscribers. The system used for voice services only. In addition to the normal subscribers calls, the control station broadcast calls to all subscribers. The total broadcast calls are 175 calls during the working hours (from 8 AM to 3 PM). The system has the following specifications :-

- twelve channels can serve the total subscriber with 2% blocking probability.
- Each subscriber generates 1.2 calls per hour with 1 min average holding time.

What is the average holding time for the broadcast calls? *(30)*

For 12 channels and 2% GOS, from Erlang B table the total traffic is 6.61 E

The traffic for each subscribers $\rho_{sub} = c_{sub} \times H_{sub} = 1.2 \times \frac{1}{60} =$ **0.02 E**

Traffic generated by from the normal subscribers calls $A_{sub} = 0.02 \times 200 =$ **4 E**

The traffic generated from the broad cast calls $A_{B.C} = 6.61 - 4 =$ **2.61 E**

Call rate for broadcast calls is $c_{B.C} = \frac{175}{3PM-8AM} = \frac{175}{7} = 25$ **call per hour**

Average Holding Time for broad cast calls $H_{B.C} = \frac{A_{B.C}}{c_{B.C}} = \frac{2.61}{25}$ **0.1044 h =** **6.264 min**

Q4. A 250 MBPS DMR utilizing 8 GHz band is connecting two location separated by 40 km. The characteristics of the system is:-

- P_T = 28 dBm and the Equalizer Improvement Factor = 2 dB.
- Antennas diameter is 1.2 m, Feeder loss is 0. 1 dB/m.
- No obstacles and the area are flat with average train, worst case climate condition
- The antenna height at one site is 40 m, and 2m kept for future height expansion is used.
- The radio has 4 dB Noise Figure and the target E_b/N_o for the link is 12 dB.

What is the system fade margin? *(30)*

$FM = P_r - C_{min}$

$P_r = P_t + G_t + G_r - L_s - L_{ft} - L_{fr} - L_b - L_{rain} - L_{others} + AEQIF$

$G = 18.5 + 20 \log D_m + 20 \log F_{GHZ} = 18.5 + 20 \log 1.2 + 20 \log 8 =$ **38.15 dB**

$L_s = 92.4 + 20 \log D_{km} + 20 \log F_{GHZ} = 92.4 + 20 \log 40 + 20 \log 8 =$ **142.5 dB**

$L_{ft} = h_t \times \alpha_f = 40 \times 0.1 =$ **4 dB**

$L_{fr} = h_r \times \alpha_f$

To find the antenna height at the second point we should calculate the highest effective obstacle, which is at the midway "$h_{mid\ way}$ since there are no obstacle.

$EC = 0.078 \frac{d_1 d_2}{k} = 0.078 \times \frac{20 \times 20}{4/3} = 23.4$ m

$R_1 = 17.3 \sqrt{\frac{1}{F_{GHZ}} \left(\frac{d_1 d_2}{d_1 + d_2}\right)} = 17.3 \sqrt{\frac{1}{8} \left(\frac{20 \times 20}{4240}\right)} = 19.3 \Rightarrow 0.6\ R_1 = 11.6$ m

$h_{mid\ way} = EC + 0.6\ R_1$ **+ Future Expansion = 23.4 + 11.6 + 2 =** **37 m**

Since the antenna height at one site 40 so the other height can be 34 m only

$L_{fr} = h_r \times \alpha_f = 34 \times 0.1 =$ **3.4 dB**

$P_r = 28 + 38.15 + 38.15 - 142.5 - 4 - 3.4 + 2 =$ **-43.6**

$C_{min} = N_{total} + \left(\frac{C}{N}\right)_{dB} = -174 + NF + \left(\frac{E_b}{N_o}\right)_{dB} + 10 \log(R)$

$= -174 + 4 + 12 + 10 \log (250{,}000{,}000) =$ **-74 dBm**

$FM = P_r - C_{min} = -43.6 - (-74) =$ **30.2 dB**

Good luck for every body

Dr. T. Benmusa

COLOGE OF ELECTRONIC TECHNOLOGY

SUBJECT: - Communications Systems
COURSE NO. : - CM 404
Spring 2017

DATE: - 26 - 4 - 2017
Midterm Exam 1 Solution
Time: 2 hours

Student Name:-	Student Number:-

PART I CLOSED BOOK EXAM

Q1 a) What is meant by multiplexing process? and what are its main types? (5)

Multiplexing is the process where multiple channels are combined for transmission over a common transmission path. The main multiplexing types are:

Frequency Division Multiplexing (FDM) - Time Division Multiplexing (TDM)
Wavelength Division Multiplexing (WDM) - Code Division Multiplexing (CDM)

b) Discuss briefly the main four ways of synchronizing the data stream between the transmitter of the data stream and the receiver? (5)

- **Synchronous (Synchronized)** All of the clocks are synchronized to a master reference clock and run at exactly the same frequency.
- **Plesiochronous (Almost Synchronized)** The clocks are not synchronized to each other so the data streams will run at slightly different rates.
- **Isochronous (Synchronized)** Data stream has the timing information embedded in it.
- **Asynchronous (Not Synchronized)** The clocks are not synchronized.

c) What is meant by signaling process? (5)

Signaling process is the process that controls the establishing and termination the connection between the parties of the channel.

d) Explain how increasing the spectrum of the information signal is preferable in Spread Spectrum technique? (5)

By increasing the spectrum of the information signal its power spreads and flatten over the spectrum. At the receiver end, the dispreading process narrows and heightens the spectrum of the required signal only, yet leaves the spectrum of the other received signal essentially unchanged. The receiver can now extract the despreaded signal from the other signals using a band pass filter. So, higher transmission spectrum gives more flatten to the signal power and make its effect on the received signal of other users lower.

e) How many data bits in 5 seconds of STM4 stream? (5)

8bit × 261row × 4 × 9 column × 8000 frame × 5 sec. = 30,006,720,000 bits

f) A PDH TDM multiplexer carries 525 voice channel, 210 PCM 64 KBPS data channels, 17 streams of 2 MBPS. What is the bite rate for the multiplexer output? (5)

Total no. of VF channels (64KBPS) = 525 +210 = 735 ch.
The no. of required E1 (2 MBPS streams) for these channels is 735/30 = 24.5 ⟹ 25 E1
So the total E1 required is 17 + 25 = 42 E1
The no. of required E2 (8 MBPS streams) for these E1's is 42/4 = 10.5 ⟹ 11 E2
E3 (34 MBPS streams) carries 4 E2 so it is not enough, and
E4 (140 MBPS streams) carries 4 E3 (4 × 4 = 16 E2) which is ok.

Student S.N.

COLOGE OF ELECTRONIC TECHNOLOGY

SUBJECT: - Communications Systems
COURSE NO. : - CM 404
Spring 2017

DATE: - 26 - 4 - 2017
Midterm Exam 1 Solution
Time: 2 hours

Student Name:-	Student Number:-

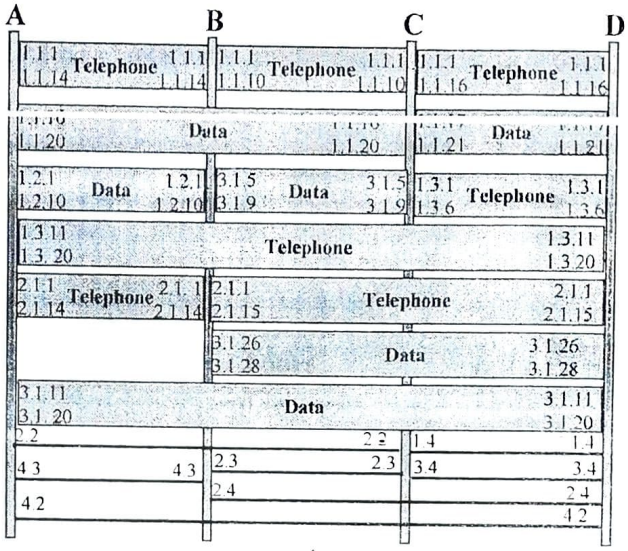
PART II OPEN BOOK EXAM

Q2. For the given multiplexer plan, if the telephone cards are serving 3 channels and data serve 5 channels. Without any additional Hardware

a) *How many 2 MBPS streams between B and D can be added?* **(5)**

Three streams only (1.2 – 3.2 – 3.3)

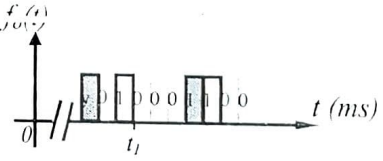
b) *How many tel and data cahnnels can be added between A and D?* **(10)**



We can add 3 tel and 0 data

E1 stream	Type	A	MUX	D
1.1	Telephone	1	9	2
	Data	0		0
1.3	Telephone	2	14	2
	Data	0		0
2.1	Telephone	1	15	0
	Data	0		0
3.1	Telephone	0	12	0
	Data	0		2

Q3. The figure below shows the output signal of one of the first level PDH multiplexer. If t_1 = 2,155.44 μs, what are the type, the bit order in the time slot, the channel number, and the frame of the shaded bits "x" and "y"? **(15)**

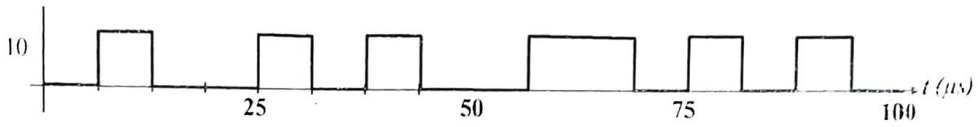


To find which frame t_1 is we divide it by frame time (125 μs) 21,55.44 / 125 =17.24352
That is mean there are 17 frames before t_1. OR t_1 in frame 18.
And t_1 came after 30.44 μs { 21,55.44 μs – (17 × 125 μs) = 21,55.44 μs – 2,125 μs} from the starting time of frame 18
To find the order of the bit starts at t_1 in the frame 18 we divide 30.44 μs by T_b or multiplying it by the bite rate R.
We have only two standards E standard and T standards. So R is either 2.048 MBPS (E standard) or 1.544 MBPS (T standard)
Let us try E standards
The order of the bit starts at t_1 is 30.44 μs × 2.048 MBPS = 62.3411 not valid because it is not integer
Let us try T standards
The order of the bit starts at t_1 is 30.44 μs × 1.544 MBPS = 47 valid because it is integer
To find the order of the bit starts at t_1 (47 -1) / 8 = 46/8 = 5.75
That is mean there are 5 channels before t_1. OR t_1 in channel 6.
So the bit starts at t_1 is the 7th bit in channel 6

"x" bit is 1st bit in time slot 8 of the frame 18 and it is signaling bit.
And "y" bit is 3ed bit in channel 7 of the frame 18 and it is data bit.

Q4. *The three bit data **"101"** has 20 KBPS bit rate are transmitted via a CDMA system using DS-SS technique. If the coded signal was given below, what is the used code for this user?* *(15)*

$S_{CDMA}(t)(V)$



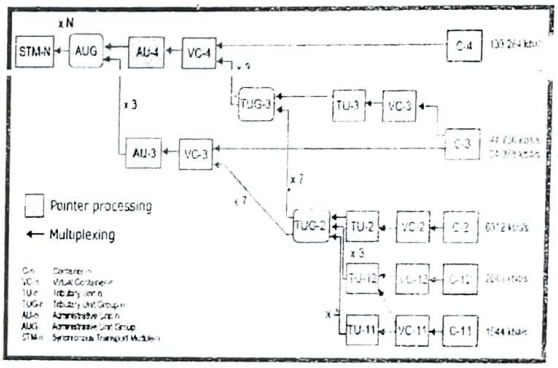
From the figure the time of output bit is 6.25 μs. and the output bit rate is 160 KBPS. So each data bit exnored with 8 code bits

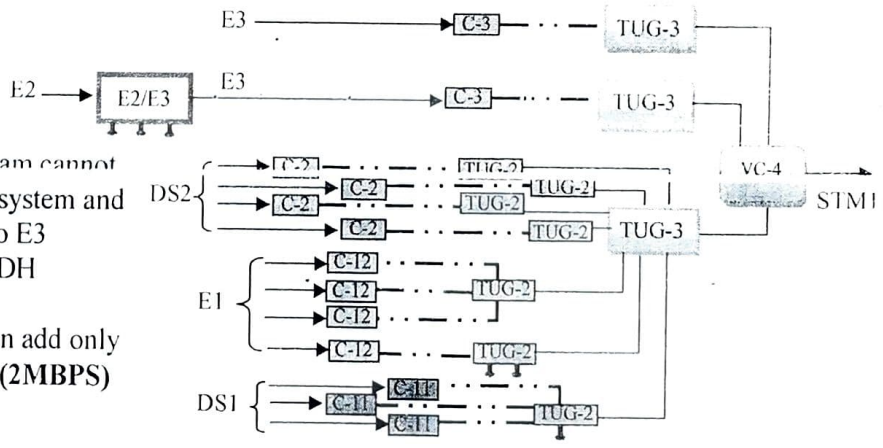
Time (μs)																
Information Data	1								0							
Coded data	0	1	0	0	1	0	1	0	0	1	1	0	1	0	1	0
Used Code	1	0	1	1	0	1	0	1	0	1	1	0	1	0	1	0

Q5. A company has SDH multiplexer system carrying the following traffic:-

- *one stream of 34 MBPS.*
- *one stream of 8 MBPS.*
- *four streams of 6MBPS*
- *four streams of 2MBPS*
- *three stream of 1.5 MBPS*

What is the maximum no. of 2 MBPS streams can be add to the system? Give reason for your answer. *(15)*





The E2 (8MBPS) stream cannot be accessed the SDH system and should be converted to E3 (34MPS) stream by PDH multiplexer first.
From the figure we can add only **TWO streams of E1 (2MBPS) streams**

Good luck for every body
Dr. T. Benmusa

COLOGE OF ELECTRONIC TECHNOLOGY

SUBJECT: - Communications Systems
COURSE NO. : - CM 404
Fall 2016

DATE: - 1 – 12 - 2016
Midterm Exam 1
Time: 2 hours

Student Name:-	Student Number:-

PART I CLOSED BOOK EXAM

Q1 a) A FDM multiplexer carries 602 VF channels:

i) What is the level of multiplexer? *(2)*

Super Master Group

ii) How many groups the system is carrying? *(3)*

51 Groups

b) When we are combining the super groups, do we introduce guard bands or not? If so what are their values? *(5)*

When we are combining the super groups we create Master Group which have 8 kHz guard band

c) What is the mathematical relation between the time slot and the maximum signal frequency at Nyquist rate? *(5)*

$$t_s = \frac{T_s}{N} = \frac{1}{f_s \times N} = \frac{1}{2 \times f_m \times N}$$

d) Why we cannot get the actual bit rate for a certain PDH MUX level when we are multiplying the bit rate of its lower level by the max no of its inputs? *(5)*

Because we have staffing or "justification" bits which are added to allow the far end receiving multiplexer to decode which bits belong to which 2 meg data stream.

Q2. a) Explain briefly the elements that make up an SDH network? *(10)*

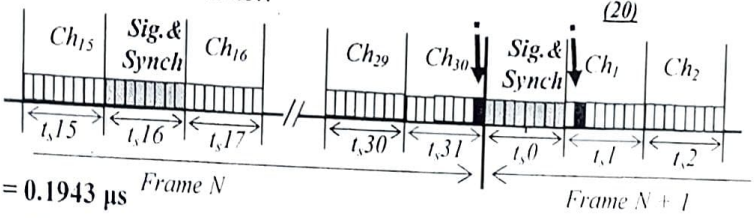
- ***Path Terminating Element***; **These are the end point devices where the lower speed channels enter and leave the SDH Network.**
- ***Digital Cross Connect***; **which can x-connect at the STM level down to individual E1 streams. An E1 stream on one STM trunk could be x-connected to another STM trunk.**
- ***Regenerator***; **Is a device that regenerates the signal.**
- ***Add/Drop Multiplexer***; **which has the ability to breakout and insert low speed channels into an STM stream.**

b) What are the advantages and disadvantages of the DSSS and FHSS from? *(10)*

Advantages of the DSSS	*Advantages of the FHSS*
• Provides security. • The signal contains low energy spread over a large bandwidth. That gives very low interference to other communication systems working in the same band and area.	• Provides security. • Does not affected by multipath fading (frequency selective fading)
Disadvantages of the DSSS	***Disadvantages of the FHSS***
• Affected by multipath fading (frequency selective fading)	• Complex due to the problems of maintaining phase coherence across frequency hops.

PART II OPEN BOOK EXAM

Q3. For one of the 1st level PDH multiplexer. if the difference between the starting time of the last bit representing the last possible channel in a certain frame and the starting time of the second bit representing the first channel in the next frame is 1.943 μs, what is the starting time of the fifth bit of the fifth channel in the fifth frame?. *(20)*



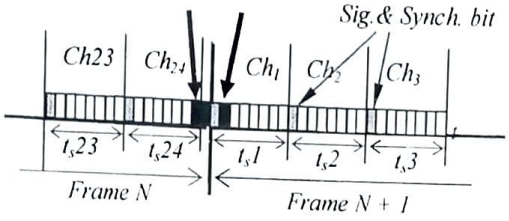
In the European standard there are 10 bits between the last bit of the last channel and the second bit of the first channel in the next frame. So T_b = 1.943/ 10 = 0.1943 μs

R = 1 / T_b = 5.147 MBPS, which is not E1. So the system is not European standard .

In North America standard there are 3 bits between the last bit of the last channel and the second bit of the first channel in the next frame.

So T_b = 1.943/ 3 = 0.64766 μs

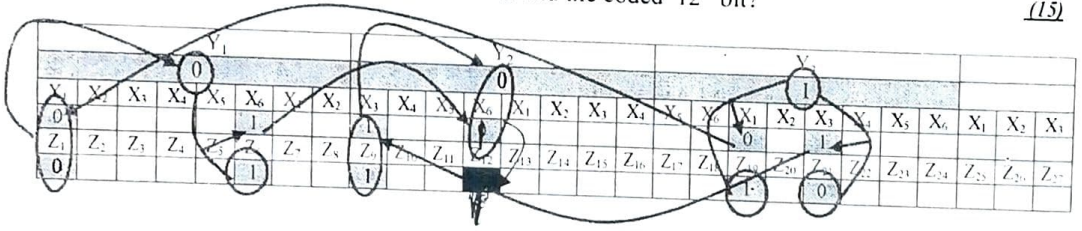
R = 1 / T_b = 1.544 MBPS which is D1. So the system is American standard .



The fifth bit of the fifth channel in the fifth frame is starting at

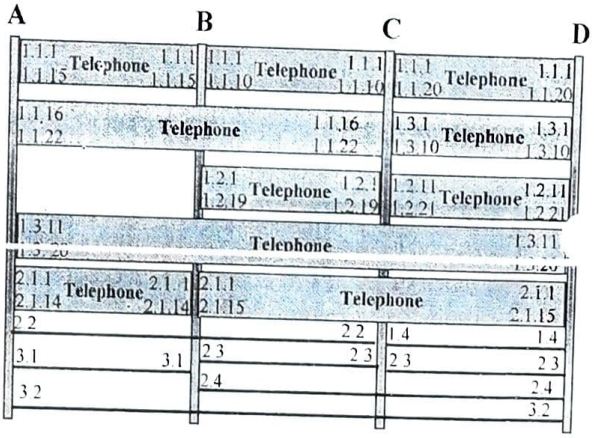
$$4 \times 193 \times \left(\frac{1}{1.544}\right) + 4 \times 8 \times \left(\frac{1}{1.544}\right) + 4 \times \left(\frac{1}{1.544}\right) = 808 \times \left(\frac{1}{1.544}\right) = 523.32\mu s$$

Q4. A DS-SS system has 6 bits spreading code and process gain of 8. If the 1st , 6th, 9th, 19th and 21st bits of the coded stream are 0, 1, 1, 1, and 0 respectively, and 3ed bits of the information data is 1. What are the information data and the coded 12th bit? *(15)*



Q5. For the given multiplexer plan, if the telephone cards are serving 4 channels.

a) How many tel cahnnels can be added between A and D without any additional hardware? *(5)*



We can add only one tel. channel

	A	MUX	D
1.1	2	8	0
1.3	2	10	0
2.1	2	15	1

b) if we need to add 153 tel. channels between A and D, what are the needed hard ware? *(15)*

We need to added 53 channel cards, 7 E1 MUX; and 3 E2/E1 MUX as follows

Channels	Requirements	Channels	Requirements
8 ch in 1.1	(2+2) ch card	9 ch in 1.2	(3+2) ch card + (1+0) E1 MUX
10 ch in 1.3	(2+3) ch card	15 ch in 2.1	(4+4) ch card
30 ch in 3.3	(8+8) ch card + (1+1) E1 MUX	30 ch in 3.4	(8+8) ch card + (1+1) E1 MUX
30 ch in 4.1	(8+8) ch card + (1+1) E1 MUX + (1+1) E2/E1 MUX	21 ch in 4.2	(8+8) ch card + (1+1) E1 MUX

Good luck for every body

Dr. T. Benmusa

Student S.N.

COLOGE OF ELECTRONIC TECHNOLOGY

SUBJECT: - Communications Systems
COURSE NO. : - CM 404
Fall 2015

DATE: - 17 – 12 - 2015
Midterm Exam 2 Solution
Time: 2 hours

Student Name:-	Student Number:-

PART II OPEN BOOK EXAM

Q2. A TETRA network serving 300 subscribers generates 9,000 packets per hours and can send 1600 bits packets with bite rate 1 MBPS. The maximum allowable delay probability is 0.02. What is the maximum number of subscriber can be handled by the network without affecting its performance? *(20)*

users the service rate $\mu = \frac{R}{\text{pcket size}} = \frac{1\times10^6}{1{,}600} = 625$ packet/s

The service time for senior user $T = \frac{1}{\mu} = 0.0016$ s $= 1.6$ ms

$\lambda = \frac{9000}{60\times60} = 2.5$ packet/s

The traffic generated per user $\rho = \lambda \times T = 2.5 \times 0.0016 = 0.004$ E $= 4\ mE$

The traffic generated by all users $A = \rho \times N = 4 \times 300 = 1200\ mE = 1.2$ E

From Erlang "C" table and for 1.2 E traffic with delay probability 0.02 we need 5 channels

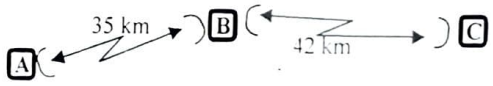
And from the table also we can have 1.5 E traffic with delay probability 0.02

So for the same performance (0.02 delay probability) we can have more subscribers generate 1.5 E. that is mean the maximum number of subscriber is

$N = \frac{A}{\rho} = \frac{1.5}{0.004} = 375$ subscriber.

(15)

Q1. The three sites "A", "B", and "C" are connected using 630 MBPS DMR at 2 GH band utilizing as shown below. The system has the following specifications :



- The radio gives 20 dBm output power and utilizes 8 PSK modulation technique with 4dB noise figure.
- The radio equipment are installed next to 3.5m antennas at the top of the towers.
- The target probability of errors for the two links is 10^{-9}.
- The area has average train. worst case climate condition.
- Only one 15 m obstacle exist at 4 km from site "B" towards site "A" .
- Adaptive equalizer is used with 2.7 dB improvement factor.

a) Find the tower height at site A? *(20)*

The tower heights calculation should be started from B-C link since it is the longest.

Since the area is flat and no obstacle between the two sites and the highest effective obstacle is the earth curvature at midway which is 42/2 = 21 km.

$EC = 0.078\frac{d_1d_2}{k} = 0.078 \times \frac{21\times21}{4/3} = 25.8$ m

$R_1 = 17.3\sqrt{\frac{1}{F_{GHZ}}\left(\frac{d_1d_2}{d_1+d_2}\right)} = 17.3\sqrt{\frac{1}{2}\left(\frac{21\times21}{42}\right)} = 39.6$ m

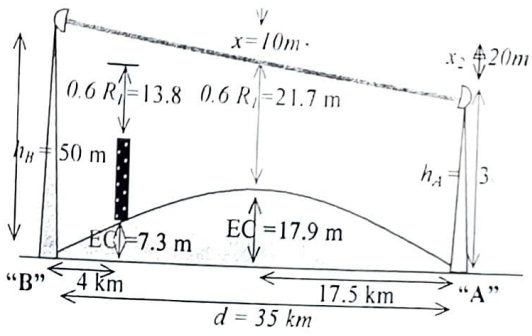
$0.6\,R_1 = 23.8$ m

Total effective obstacle height = 49.6 m

Take the antenna height at both sites "C" and "B" $h_C = h_B =$ 50 m

Now for A-B link	obstacle	Mid way
Distance from "b" (km)	4	17.5

Obstacle height (m)	15	0
EC (m)	7.3	17.9
R1 (m)	23	36.2
0.6 R1 (m)	13.8	21.7
Total effective height (m)	36.1	39.6 ≈ 40 m



Very clear the existing obstacle has no effect and the dominant height is the mid way height. Since site "B" tower is 50 m height and the effective obstacle height is 40 m at mid way, thus the **tower height at sit "A" is 30 m**.

b) What is the maximum achievable link availability? *(20)*

The Path Loss General Equation

$P_{r\,min} = P_t + G_t + G_r - L_s - \cancel{L_f} - \cancel{L_b} - \cancel{L_{rain}} - \cancel{L_{others}} + \text{EQIF}$

$G = 18.5 + 20 \log D_m + 20 \log F_{GHZ} = 18.5 + 20 \log 3.5 + 20 \log 2 = 35.4$ dB

$L_s = 32.4 + 20 \log D_{km} + 20 \log F_{MHZ} = 32.4 + 20 \log 35 + 20 \log 2000 = 129.3$ dB

$P_r = P_t + G_t + G_r - L_s + \text{EQIF}$

$= 20 + 35.4 + 35.4 - 129.3 + 2.7 =$ **-35.8 dBm**

From the curve for 8 QPSK at 10^{-9} P_e ; $\left(\frac{E_b}{N_o}\right)_{dB} = 16$ dB

$C_{min} = N_{total} + \left(\frac{C}{N}\right)_{dB} = -174 + \text{NF} + \left(\frac{E_b}{N_o}\right)_{dB} + 10 \log(R)$

$= -174 + 4 + 16 + 10 \log (630{,}000{,}000) =$ **-66 dBm**

$FM = P_r - C_{min} = -35.8 - (-66) =$ **30.2 dB**

$FM = 30 \log D_{km} + 10 \log(6\ A\ B\ F_{GHz}) - 10 \log(1-R) - 70$

$10 \log(1-R) = 30 \log D_{km} + 10 \log(6\ A\ B\ F_{GHz}) - FM - 70$

$= 30 \log 35 + 10 \log(6 \times 1 \times 1 \times 2) - 30.2 - 70 = -43$

$1 - R = 10^{\frac{-43}{10}} = 5 \times 10^{-5} \Rightarrow$

R = 0.99995 = 99.995 %

Good luck for every body

Dr. T. Benmusa

Q2. A 900MBPS DMR link working at 10 GHz using 8PSK radios is connecting two points separated by 30 km, and has the following specifications:-

- The radio has 30.2 dBm output power with 3 dB noise figure.
- The specific feeder loss is 0.1 dB/m.
- Assume the radio located at the bottom of the tower.
- The area has average train, no obstacles, hot, and humid climate.
- Adaptive equalizer is used with 3 dB improvement factor.
- The link availability is 99.99% and 10-6 the target probability of error:-
- Rain attenuation is 2 dB.
- Assume the radio located at the bottom of the tower and no branching loss.

Assuming both ends are using identical antennas, what is their diameter? *(20)*

From the curve for 8 QPSK at 10^{-6} P_e ; $\left(\frac{E_b}{N_o}\right)_{dB} = 14$ dB

$$\left(\frac{C}{N}\right)_{dB} = \left(\frac{E_b}{N_o}\right)_{dB} - 10\log(BW) + 10\log(R)$$

$$= 14\text{ dB} - 10\log(\text{BW}) + 10\log(9\times10^8) = 103.45\text{ dB} - 10\log(\text{BW})$$

$N_{total} = 10\log(kTBN_F) = -174 + 10\log(\text{BW}) + N_{F\,dB} = -171 + 10\log(\text{BW})$

$C_{min} = N_{total} + \left(\frac{C}{N}\right)_{dB} = -171 + \cancel{10\log(\text{BW})} + 103.54\text{ dB} - \cancel{10\log(\text{BW})}$

$C_{min} = -67.45$ dBm

$FM = 30\log D_{km} + 10\log 6ABF_{GHz} - 10\log(1-\text{Reliability}) - 70$ dB

$= 30\log 30 + 10\log(6\times1\times1/2\times10) - 10\log(1-0.9999) - 70$ dB $= 29$ dB

$P_r = FM + C_{min} = 29$ dB $- 67.45$ dBm $= -38.45$ dBm

The Path Loss General Equation

$P_r = P_t + G_t + G_r - L_s - L_f - \cancel{L_b} - \cancel{L_{others}} - L_{rain} + AEQIF$

$G_t = G_r = G$ then

$2G = P_t - P_r - L_s - L_f - L_{rain} + AEQIF$

$L_s = 92.4 + 20\log D_{km} + 20\log F_{GHZ} = 92.4 + 20\log 30 + 20\log 10 = 141.9$ dB

Since the area is flat and no obstacle between the two sites and the highest effective obstacle is the earth curvature at midway which is 30/2 = 15 km.

$EC = 0.078\frac{d_1d_2}{k} = 0.078\times\frac{15\times15}{4/3} = 13.2$ m

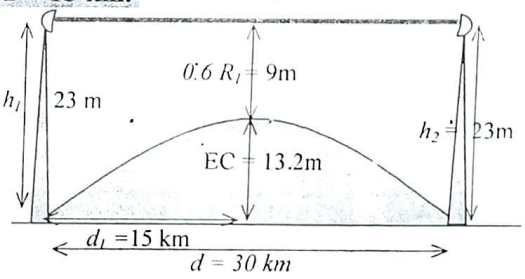
$R_1 = 17.3\sqrt{\frac{1}{F_{GHZ}}\left(\frac{d_1d_2}{d_1+d_2}\right)} = 17.3\sqrt{\frac{1}{10}\left(\frac{15\times15}{30}\right)} = 15$ m

$0.6\,R_1 = 9$ m

Total effective obstacle height = 22.2 m

Take the antenna height at both sites $h_1 = h_2 = 23$m

$L_f = h_1\times\alpha_f + h2\times\alpha_f = 2\times 23\text{ m}\times 0.1\text{ dB/m} = 4.6$ dB



$2G = P_t - P_r - L_s - L_f - L_{rain} + AEQIF$

$= 30.2$ dBm $-(-38.45$ dBm$) - 141.9$ dB $- 4.6$ dB $- 2$ dB $+ 3$ dB $= 76.85$ dB

$G = 76.85/2 = 38.425$ dB

But the antenna gain $G = 18.5 + 20\log D_m + 20\log F_{GHz}$

$D_m = 10^{\frac{G-18.5-20\log F_{GHz}}{20}} = 10^{\frac{38.425-18.5-20\log 10}{20}} = 1$ m

Good luck for every body

Dr. T. Benmusa

Q1. A TETRA network serving 300 normal subscribers can send 1280 bits packets with bite rate 64 kbps, and 50 seiner subscribers have the capability of sending 20,000 bits packets with bite rate 2 Mbps. The system has the following specifications :-

- The transmitters work on class 1 for both mobile and base station.
- The BS has -110 dBm threshold receiver power, 5.11 dB antenna gain and no feeder loss.
- The system uses full 3 carriers.
- The hand held has -100 dBm threshold receiver power, 2.12 dB antenna gain and no feeder loss.
- The maximum allowable path loss is 142 dB
- shadow loading Standard deviation is 8 dB.
- The delay probability 0.02.
- Each of senior subscriber generates 720 packets per hours.

a) What is the percentage of cell coverage? *(15)*

For Uplink hand held(HH) to base station(BS)

$P_{r\,base} = P_{t\,HH} + G_{HH} - L_{HH} - L_P + G_B - L_B - M_{down}$

Or, $M_{down} = P_{t\,HH} + G_{HH} - L_{HH} - L_P + G_B - L_B - P_{r\,base}$

$P_{t\,HH} = 30W \equiv 14.77\ dBW \equiv 44.77\ dBm$ since it works in class 1

So, $M_{down} = 44.77\ dBm + 2.12\ dB - 0 - 142\ dB + 5.11\ dB - 0 - (-110\ dBm) = 20\ dB$

For Downlink hand held(HH) to base station(BS)

$M_{up} = P_{t\,B} + G_B - L_B - L_P + G_{HH} - L_{HH} - P_{r\,HH}$

$P_{t\,HH} = 40W \equiv 16\ dBW \equiv 46\ dBm$ since it works in class 1

$M_{up} = 46\ dBm + 5.11\ dB - 0 - 142\ dB + 2.12\ dB - 0 - (-100\ dBm) = 11.23\ dB$

So we should take the margin of the uplink (M_{up}) since it is the smaller. The coverage area for smaller FM for sure can be obtained with higher FM.

From the graph, the percentage of cell coverage for 11.23 dB and 8 dB shadow loading Standard deviation is 96%

b) How many packets each normal user is send per second? *(15)*

For senior users the service rate $\mu_{sen} = \frac{R_{sen}}{\text{pcket size}_{sen}} = \frac{2\times10^6}{20{,}000} = 100$ packet/s

The service time for senior user $T_{sen} = \frac{1}{\mu_{sen}} = 0.01$ s

$\lambda_{sen} = \frac{720}{60\times60} = 0.2$ packet/s

The traffic generated by senior user $\rho_{sen} = \lambda_{sen} \times T_{sen} = 0.2 \times 0.01 = 2\ mE$

The traffic generated by all senior users $A_{sen} = \rho_{sen} \times N_{sen} = 2 \times 50 = 0.1$ E

For 3 RF carrier we have $3 \times 4 = 12$ channels,

From Erlangs C table, for 12 channels and 0.02 delay probability, total traffic A_{total} is 5.9 E

The traffic generated by all normal users $A_{norm} = A_{total} - A_{sen} = 5.9 - 0.1 = 5.8$ E

The traffic generated by normal user $\rho_{norm} = \frac{A_{norm}}{300} = \frac{5.8}{300} = 0.0193$ E $= 19.3\ mE$

For normal users the service rate $\mu_{norm} = \frac{R_{norm}}{\text{pcket size}_{norm}} = \frac{64{,}000}{1{,}280} = 50$ packet/s

The service time for normal user $T_{\text{norm}} = \frac{1}{\mu_{\text{norm}}} = 0.02$ s

$\lambda_{norm} = \frac{\rho_{norm}}{T_{\text{norm}}} = \frac{0.0193}{0.02} = 0.965$ packet/s

COLOGE OF COMPUTER TECHNOLOGY

Subject: Optical Network
Course Code. :- FNT 330
Fall 2014

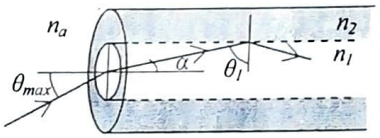
Date: 18 – 01 - 2015
Final Exam Solution
Time: 2.0 hours

Student Name:-	Student Number:-

Q1. a) Show that the numerical aperture $NA = \sqrt{n_1^2 - n_2^2}$? *(5)*

Using Snell's Law

$n_a \sin\theta_{max} = n_1 \sin\alpha \Rightarrow \sin\theta_{max} = n_1 \sin\alpha$



For the reflection of the ray inside the fiber then:

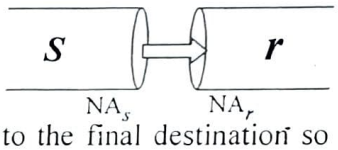
$n_1 \sin\theta_1 = n_2 \sin 90 = n_2$

$n_1 \sin(90-\alpha) = n_2 \Rightarrow n_1 \cos\alpha = n_2$

$$\cos\alpha = \frac{n_2}{n_1}, \text{ and } \sin\alpha = \sqrt{1-\left(\frac{n_2}{n_1}\right)^2}$$

$$NA = \sin\theta_{max} = n_1 \sin\alpha = n_1\sqrt{1-\left(\frac{n_2}{n_1}\right)^2} = \sqrt{n_1^2 - n_2^2}$$

b) Suppose we have two fiber as shown. why there are a loss if $NA_s > NA_r$ and no loss if $NA_s < NA_r$? *(5)*



If $NA_s > NA_r$ some rays come out from "S" will go inside "r" and other rays will go outside "r" and will not continue to the final destination so there are loss. But if $NA_s < NA_r$ all come out from "S" will go inside "r" so, no losses but also there is no gain.

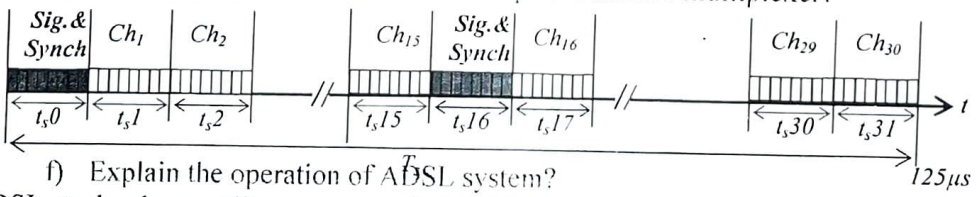
c) For PDH multiplexer, give number in the boxes below? *(5)*

i) In DS2 there are [4] of DS1
ii) In DS4 there are [42] of DS2
iii) In E5 there are [64] of E2
iv) In E4 there are [64] of E1
v) In E4 there are [20] of DS2

d) Explain Bandwidth – distance product and they are affecting each other? *(5)*

The bandwidth in Fiber optics system is not the same for all lengths it is increased as distance decrease and decreases as distance increase. That is because dispersion increases by increasing the distance so pulse width should by longer and bite rate should be lower, which is the system bandwidth.

e) Sketch the farm of the ITU –T European standard multiplexer? *(5)*



f) Explain the operation of ADSL system? (5)

DSL technology utilizes more of the frequencies in copper line by splitting line frequencies, using the higher frequencies for data and the lower frequencies for voice; 0 to 4 kHz voice, 10 to 2.2 MHz for data. ADSL has the characteristic that the data can flow faster in one direction than the other, a symmetrically

Q2. For one of the 1st level PDH multiplexer, if the difference between the starting time of the first bit representing the second channel in a certain frame and the starting time of the second bit representing the third channel in the same frame is 4.39453125 μs, what is the starting time of the fifth bit of the fifth channel in the second frame? *(10)*

The difference between the first bit representing the second channel in a certain frame and the second bit representing the third channel in the same frame is nine bits, so;

$9\,T_b = 4.39453125\ \mu s \Rightarrow T_b = \frac{4.39453125}{9} = 0.48828125 \Rightarrow R = \frac{1}{T_b} = 2.048\ \text{MBPS}$

So, the system is ITU –T European, and the starting time of the fifth bit of the fifth channel in the second frame occurs at;

$1 \times T_s + 4 \times (8 \times T_b) + 4 \times T_b = 125 + 36 \times 0.48828125 = 142.578125\ \mu s$

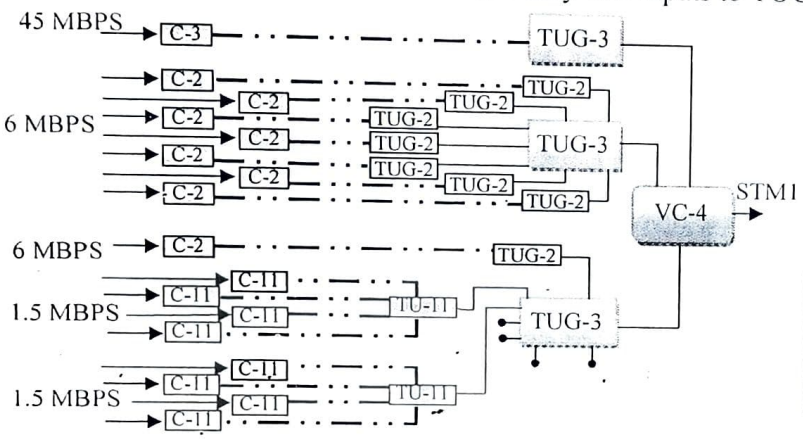
Q3. Suppose we have a SDH multiplexer carrying one stream of 45 MBPS, eight streams of 6 MBPS, eight streams of 2 MBPS, and two stream of 1.5 MBPS .

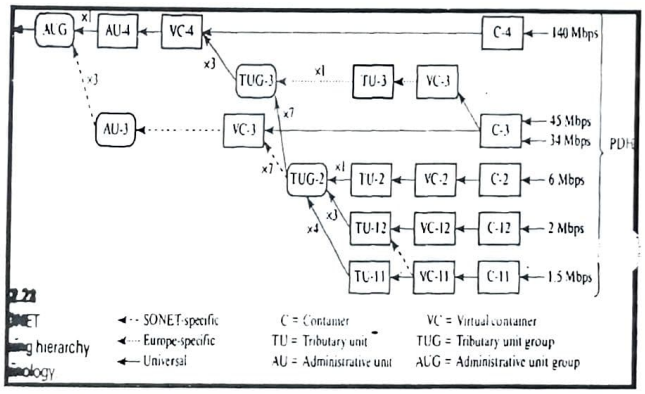
a) What is the maximum no. of E1 streams can be add to the system? *(5)*

From the fig. below three four inputs to TUG-3 are free so we can add $2 \times 3 + 1 = 7$ E1's

b) Can we add 5 streams of DS1 to the system? And Why? *(5)*

Yes because 5 DS1's need only two inputs to TUG-3, and we have two inputs free.





Q4. 150 km STM1 fiber Optics Link has the following specification :-

- The output ray of the LED pulses at FO terminal has 1 ns width and 10 dBm.
- The LED life time 2 years and the power reduction factor is 0.5 dB per year.
- The threshold power of the receiving terminal is -5 dBm.
- The cable has 0.05 dB/km loss, and splicing loss is 0.1dB.
- The losses of area difference, misalignment, and air gap are zeros.
- The transmitter and receiver coupling losses are 0.969 dB and 0.177 dB respectively.
- The terminal numerical aperture NA = 0.006 at both ends.
- Power margin for additional splicing is 2.45 dB.

a) What is pulse width at the receiver? *(10)*

Since $NA_t = NA_r$ so either L_{NAt} or L_{NAr} equal 0. And since L_{ct} is higher than L_{cr} so L_{NAr} =0.

$L_{cr} = 0.177\ \text{dB} = L_{refl} + \cancel{L_{NAr}} = L_{refl} = -20\log(1-r) \Rightarrow 1 - r = 10^{\frac{0.177}{20}} \Rightarrow r = 0.04$

$r = 0.04 = \left(\frac{n_1 - n_a}{n_1 + n_a}\right)^2 = \left(\frac{n_1 - 1}{n_1 + 1}\right)^2 \Rightarrow \left(\frac{n_1 - 1}{n_1 + 1}\right) = 0.2 \Rightarrow 0.8\,n_1 = 1.2 \Rightarrow n_1 = 1.5$

$L_{ct} = 0.969\ \text{dB} = L_{refl} + L_{NAt} = 0.177 + L_{NAt} \Rightarrow L_{NAt} = 0.792\ \text{dB}$

$L_{NAt} = 20\log\frac{NA_t}{NA_f} \Rightarrow \frac{NA_t}{NA_f} = 10^{\frac{L_{NAt}}{20}} = 10^{\frac{.792}{20}} = 1.095 \Rightarrow NA_f = \frac{NA_t}{1.095} = \frac{0.006}{1.095} = 0.00547$

$NA_f = \sqrt{n_1^2 - n_2^2} \Rightarrow n_2 = \sqrt{n_1^2 - NA_f^2} = \sqrt{1.5^2 - 0.00547^2} = 1.49999$

$\frac{\Delta t}{L} = \frac{n_1 - n_2}{c} = \frac{1.5 - 1.49999}{3\times10^8} = 0.03333\,\frac{ns}{km} \Rightarrow \Delta t = \frac{\Delta t}{L} \times L = 0.03333 \times 150 = 5\ \text{ns}$

$T_{b\,min} = \tau + \Delta t_{total} = 1\ ns + 5\ ns = 6\ ns$

Student S.N.

COLOGE OF ELECTRONIC TECHNOLOGY

SUBJECT: - Communications Systems
COURSE NO. : - CM 404
Fall 2015

DATE: - 22 – 11 - 2015
Midterm Exam 1
Time: 2 hours

Student Name:-	Student Number:-

PART I CLOSED BOOK EXAM

Q1 What is meant by?

i) Guard band? *(3 marks)*

ii) Sampling time? *(3 marks)*

iii) E1 multiplexer? *(3 marks)*

iv) The process gain in spread Spectrum systems? *(3 marks)*

v) Signaling channel card? *(3 marks)*

Q2. a) What is the mathematical expression relating the bit time and the sampling frequency? *(10 marks)*

b) How many non data bits in 3 seconds of SDH stream data? *(10 marks)*

c) explain briefly the main concept of FHSS systems? *(10 marks)*

Student S.N.

COLOGE OF ELECTRONIC TECHNOLOGY

SUBJECT: - Communications Systems | **DATE: - 22 – 11 - 2015**
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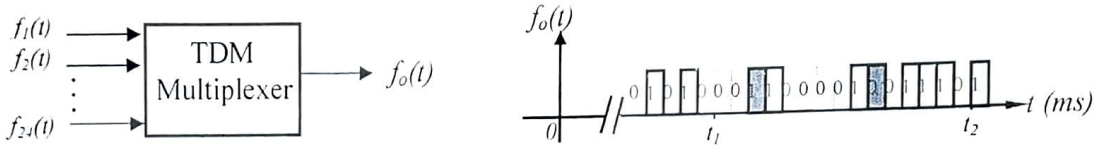
PART II OPEN BOOK EXAM

Q3. The figure below shows one of the first level PDH multiplexer has *"24"* input signals. Part of the fifth frame output signal was represented by $f_o(t)$ below. Knowing that some of the bits shown in $f_o(t)$ are related to the 16th signal, and the shaded two bits in the $f_o(t)$ are part of the frame signaling and synchronization bits.

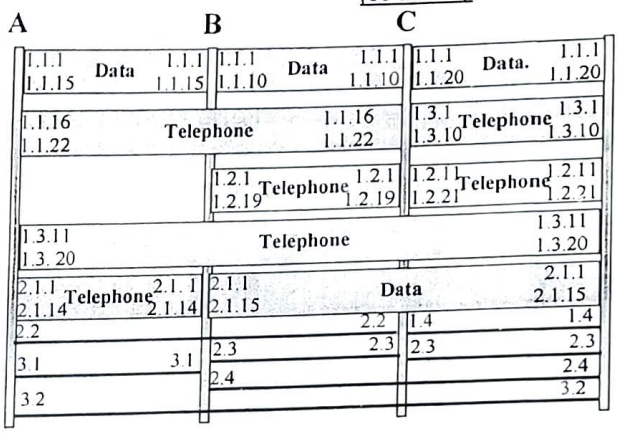


a) What is the value of t_1 ? ***(15 marks)***

b) From the given $f_o(t)$ stream, what is the bits related the 15th channels? ***(10 marks)***

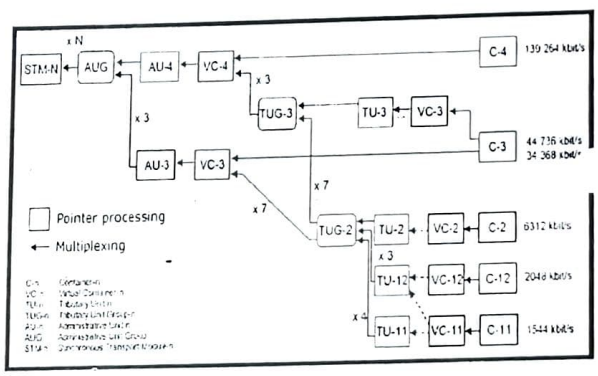
Q4. For the given multiplexer plan, if the telephone & data cards are serving 4 & 5 channels respectively. Complete the table below for the bill of quantity of the main Multiplexer equipment at stations B and D? *(15 marks)*

Description	St."B"	St."D"



Q5. Suppose we have a SDH multiplexer carrying one stream of 34 MBPS, eight streams of 6 MBPS, five streams of 2 MBPS, and five stream of 1.5 MBPS .

a) What is the maximum no. of DS1 streams can be add to the system? *(10 marks)*



b) On the top of the capacity mentioned in part "a", how many extra E1 streams can be add ? *(5 marks)*

Good luck for every body

Dr. T. Benmusa