ETL - Telecommunication Systems

T104

Thursday, 07/11/2013

8:30 - 11:30 AM

WORKFORCE DEVELOPMENT AUTHORITY

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ADVANCED LEVEL NATIONAL EXAMINATIONS, 2013;

TECHNICAL AND PROFESSIONAL TRADES

EXAM TITLE: Telecommunication Systems

OPTION: Electronics and Telecommunication (ETL)

DURATION: 3hours

INSTRUCTIONS:

The paper is contains Three **(3)** Sections:

Section I: Fifteen **(15)** questions, all **Compulsory**. **55marks**

Section II: Five **(5)** questions, **Choose any Three (3)**. **30marks**

Section III: Two **(2)** questions, **choose any one (1).** **15marks**

Section I: Attempt all the 15 questions. **55marks**

01. Describe the bandwidth of an antenna. **1mark**

02. What is a good way to get maximum performance from a Yagi antenna? **2marks**

03. Identify two types of Omni-directional antennas. **2marks**

04. Describe the characteristics of F region of Ionosphere. **2marks**

05. Identify two operations or steps involved in transformation of analog signal into digital signal for a digital communication system. **2marks**

06. The power of a transmitter is increased from 5 watts to 50 watts by a linear amplifier; express the power gain in dB. **3marks**

07. Describe briefly a waveguide. **3marks**

08. For each form of signal represented bellow, identify which parameters are modified. **4marks**

	Signal
a)	
b)	
c)	
d)	

09. Identify in order of signal processing the main elements of FM radio receiver. **4marks**

10. Assume A, P be carrier amplitude and power of message respectively. Express the transmitted power in case of each of the following modulation or demodulation format. **4marks**

a) AM coherent detection
b) DSB-SC coherent detection
c) SSB coherent detection
d) Am envelope detection

11. Describe the expression of instantaneous frequency in frequency modulation type. **5marks**

12. Identify five basic factors with which the television system must deal for successful transmission and reception of pictures. **5marks**

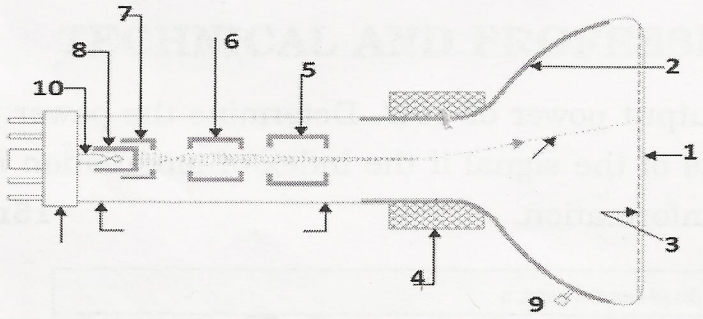
13. Identify the basic elements involved in communication system to transfer information from one point to another and precise the role of each element. **6marks**

14. Identify six (6) among the general functions performed by a digital communications receiver. **6marks**

15. Identify six basics parameters that should be considered and measured during the designing process of an antenna. **6marks**

Section II: Attempt any three (3) questions. 30marks

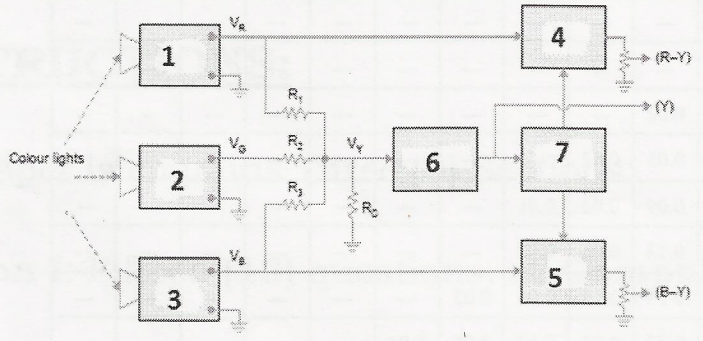
16. Identify different elements of a television picture tube represented by numbers (1, 2, 3, 4, 5, 6, 7, 8, 9 and 10) on the following diagram. **10marks**



17. a) Identify seven (7) functions that can be controlled on a remote control of a color television receiver. **7marks**

b) What are the basic elements of a television receiver remote control? **3marks**

18. Complete the following diagram by finding the function that corresponds to the number (1, 2, 3, 4, 5, 6 and 7) and determine mathematical expression of R-Y; B-Y and Y. **10marks**



19. An AM wave is represented by the expression: v = 5(1+0.6cos6280t) sin 221 X 104t volts

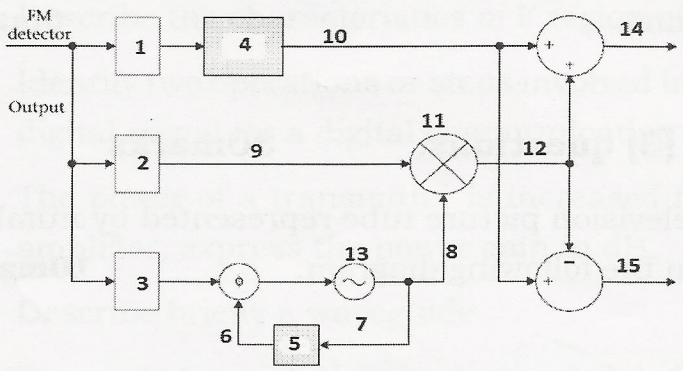
(i) What are the maximum and minimum amplitudes of the AM wave?

(ii) What frequency components are contained in the modulated wave? **10marks**

20. Total internal reflection is the back bone of optical communication. Explain and add diagram if possible. **10marks**

Section III: Choose and Answer any one (1) question. 15marks

21. The following is a typical stereo demodulator block diagram; determine what is corresponding to each number (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15) in the diagram. It is not necessary to draw the diagram. **15marks**



22. An FM transmitter has an output power of 10W. Determine the power in the various frequency components of the signal if the index of modulation is 1.0. Use the table below for more information. **15marks**

x	Bessel-function order, n																
m_f	J_0	J_1	J_2	J_3	J_4	J_5	J_6	J_7	J_8	J_9	J_{10}	J_{11}	J_{12}	J_{13}	J_{14}	J_{15}	J_{16}
0.00	1.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.25	0.98	0.12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0.5	0.94	0.24	0.03	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1.0	0.77	0.44	0.11	0.02	—	—	—	—	—	—	—	—	—	—	—	—	—
1.5	0.51	0.56	0.23	0.06	0.01	—	—	—	—	—	—	—	—	—	—	—	—
2.0	0.22	0.58	0.35	0.13	0.03	—	—	—	—	—	—	—	—	—	—	—	—
2.41	0	0.52	0.43	0.20	0.06	0.02	—	—	—	—	—	—	—	—	—	—	—
2.5	−.05	0.50	0.45	0.22	0.07	0.02	0.01	—	—	—	—	—	—	—	—	—	—
3.0	−.26	0.34	0.49	0.31	0.13	0.04	0.01	—	—	—	—	—	—	—	—	—	—
4.0	−.40	−.07	0.36	0.43	0.28	0.13	0.05	0.02	—	—	—	—	—	—	—	—	—
5.0	−.18	−.33	0.05	0.36	0.39	0.26	0.13	0.05	0.02	—	—	—	—	—	—	—	—
5.53	0	−.34	−.13	0.25	0.40	0.32	0.19	0.09	0.03	0.01	—	—	—	—	—	—	—
6.0	0.15	−.28	−.24	0.11	0.36	0.36	0.25	0.13	0.06	0.02	—	—	—	—	—	—	—
7.0	0.30	0.00	−.30	−.17	0.16	0.35	0.34	0.23	0.13	0.06	0.02	—	—	—	—	—	—
8.0	0.17	0.23	−.11	−.29	−.10	0.19	0.34	0.32	0.22	0.13	0.06	0.03	—	—	—	—	—
8.65	0	0.27	0.06	−.24	−.23	0.03	0.26	0.34	0.28	0.18	0.10	0.05	0.02	—	—	—	—
9.0	−.09	0.25	0.14	−.18	−.27	−.06	0.20	0.33	0.31	0.21	0.12	0.06	0.03	0.01	—	—	—
10.0	−.25	0.04	0.25	0.06	−.22	−.23	−.01	0.22	0.32	0.29	0.21	0.12	0.06	0.03	0.01	—	—
12.0	0.05	−.22	−.08	0.20	0.18	−.07	−.24	−.17	0.05	0.23	0.30	0.27	0.20	0.12	0.07	0.03	0.01

"Table of Bessel Functions"

SECTION I.

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1. Bandwidth is the property of an antenna, which defines the range of frequencies to which it will respond. 1 — 1 mark

2. performance of Yagi antenna depends:
   - optimize the lengths of its elements 1 — Consider only two. — 2 marks.
   - optimize the spacing of its elements 1
   - increase the number of directors. 1

3. Two types of omni-directional antennas:
   - Dipole 1
   - Ground plane 1 — Consider only 2. — 2 marks.
   - loop antenna 1

4. F region characteristics (of ionosphere):
   - It is the highest region of ionosphere 1 — Consider two.
   - During the day; F region includes the F1 and F2 layers. 1 — 2 marks.
   - F1 and F2 combine at night to form the F layer. 1

5. Analog to digital process:
   - Sampling 1
   - Quantization 1 — 2 marks.

6. Gain of power: $A_P = \frac{P_{out}}{P_{in}} = \frac{50}{5} = 10$ (1, 1) ; $P_{GdB} = 10\log A_P = 10\text{dB}$ (1)

   (or)

   Power gain in dB $= 10\log\left(\frac{P_{out}}{P_{in}}\right) = 10\log 10 = 10\,dB$ (1, 1, 1) — 3 marks.

07. - A waveguide is a conducting tube through which energy is transmitted in the form of electromagnetic or microwaves waves. 1
   - The tube acts as a boundary that confines the waves in the enclosed space. 1 — Consider only three — 3 marks.
   - The electromagnetic fields are propagated through the waveguide by means of reflections against its inner walls, which are considered perfect conductors. 1
   - The signals can be conducted in either TEM, TE or TM mode. 1

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08. a) Amplitude and phase 1
b) Amplitude 1
c) Phase 1
d) Frequency 1

4 marks

09. Main elements of FM radio receiver:
a) Band-pass filter 1
b) Limiter 1 or
c) Discriminator 1
d) Low-pass filter 1

or

a) Antenna 1
b) Filter and Amplifier 1
c) Mixer 1
d) Detector / Demodulator 1
e) Speaker 1

Consider only four.

4 marks

10.

(De)-Modulation format.	Transmitted Power.
a) AM Coherent detection	$(A^2+P)/2$ 1
b) DSB-SC coherent detection	$(A^2P)/2$ 1
c) SSB coherent detection	$(A^2P)/4$ 1
d) AM envelop detection	$(A^2+P)/2$ 1

4 marks.

11. $f_i = f_c + \Delta f \cos \omega_m t$ 0.5 Hz 0.5 = 1

f_i = is the instantaneous frequency 0.5 [Hz] 0.5 = 1
f_c = is the carrier frequency 0.5 [Hz] 0.5 = 1
Δf : is the frequency deviation 0.5 [Hz] 0.5 = 1
ω_m : is the modulating signal frequency or message signal 0.5 [rad/s] 0.5 = 1.

5marks.

12. a) Gross structure : Geometic form and aspect ratio of the picture 1
b) Image Scanning : Scanning and its sequence 1
c) Number of Scanning lines : Resolution of picture details 1
d) Flicker : Interlaced Scanning 1
e) Fine structure : Vertical and horizontal resolution 1
f) Tonal gradation : Picture brightness transfer characteristics of the system. 1

Consider only five.

5marks

13. Basic Elements of communication system and their role:

a) Source of Information: where the information is coming from 1
b) Transmitter: converts message into a form suitable for transmittion 1
c) Channel: The physical medium through which pass message. 1
d) Receiver: Reconstruct a recognizable form of the message 1
e) Destination of message: where the message is to be useful 1
f) Noise: Attenuation. 1

6 marks.

14. Functions of digital communication (system) receiver:

i- carrier frequency recovery (carrier clock) 1
ii- Symbol lock (symbol clock recovery) 1
iii- Signal decomposition to I (in phase) and Q (quadrature) Components 1
iv- Determining I and Q values for each symbol (slicing). 1
v- Decoding and de-interleaving 1
vi- Expansion to original bit stream 1
vii- Digital to Analog conversion, if required 1

Consider only six

6 marks.

15. Basic parameters of antenna:

- Frequency band of operation 1
- Polarization 1
- Input impedance 1
- Radiation patterns 1
- gain 1
- Efficiency 1
- Selectivity 1
- size / length 1
-

Consider six only

6 marks.

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SECTION II:

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16. Elements of Television picture tube:

1. Screen 1
2. Final anode 1
3. Phosphor coating 1
4. Deflection coils 1
5. Focusing anode 1
6. Accelerating anode 1
7. control grid 1
8. Cathode 1
9. EHT or HV connector 1
10. Heater 1

10 marks

17. a) Seven functions of Remote control of TV receiver:

- ON-OFF 1
- Volume-up 1
- volume-down 1
- channel selection 1
- color-up 1
- color-down 1
- Language selection 1
- Brightness 1
- Antenna rotation 1
- TV password protect (locking) 1

Consider seven only.

10 marks

b) Basic elements of TV receiver remote control:

- Transmitting box (used at the distance from the receiver) 1
- Intercept and signal processing unit (inside the receiver) 1
- mechanical drive or electronic control unit (inside the receiver) 1

18. 1. Red camera 1
2. Green camera 1
3. Blue camera 1
4. (R-Y) Adder 1
5. (B-Y) Adder 1
6. Y Amplifier 1
7. -Y (inverter) 1

$Y = 0.30 V_R + 0.59 V_G + 0.11 V_B$ 1

$R-Y = 0.70R - 0.59G - 0.11B$ 1

$B-Y = 0.89B - 0.59G - 0.30R$ 1

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10 marks

19. $V = 5(1 + 0.6 \cos 6280t) \sin 221 \times 10^4 t$ volts.

(i) Maximum amplitude of AM wave $= E_c + m_a E_c$ 1

$= 5 + 0.6 \times 5 = 8$ V 1

Minimum amplitude of AM wave $= E_c - m_a E_c$ 1

$5 - 0.6 \times 5 = 2$ V 1

(ii) The AM wave will contain three frequencies: ~~fc of~~

- $f_c - f_s$
- f_c
- $f_c + f_s$

$f_c = \frac{221 \times 104}{2 \times 3.14} = \frac{\omega_c}{2\pi} = 3.65$ KHz 1 1

$f_s = \frac{6280}{2 \times 3.14} = \frac{\omega_m}{2\pi} = 1.0$ KHz 1 1

10 marks

* The carrier frequency : $f_c = 3.65$ KHz 1
* The maximum / upper frequency : $f_c + f_s = 3.65 + 1 = 4.65$ KHz
* The minimum / lower frequency : $f_c - f_s = 3.65 - 1 = 2.65$ KHz 1

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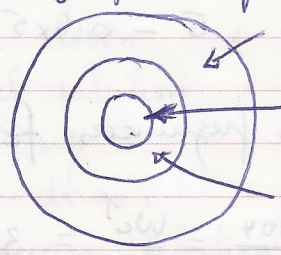
20. Explain why total internal reflection is back bone of optical communication :

- Modern optical fiber is formed by two layers of glass 1
- The fiber core (is surrounded by a concentric of lower index glass known as cladding (1).
- The total internal reflection occurs at the core-cladding interface
- In fibers designed for high speed telecommunications, the core is only a few microns in diameter not much larger than the wavelength of the light used. 1
- The refractive index of a typical strand is 1.7 and the refractive index of the material coated over it is 1.5. 1
  (core index n_1 > cladding index n_2).
- The signal transmitted through the optic fiber is light 1

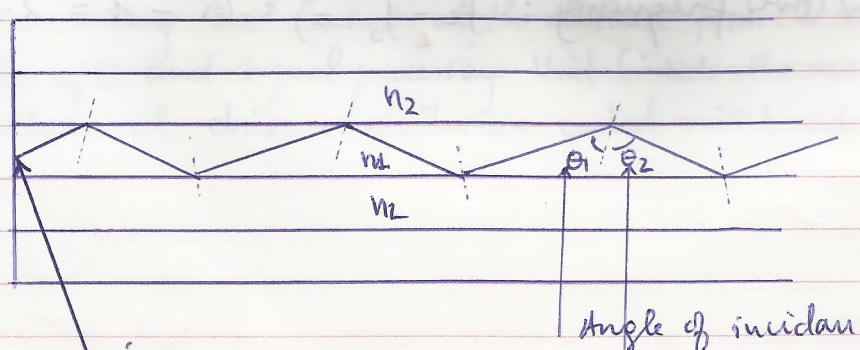
Consider four only.

10 mark

The parts of fiber optic:



- glass or plastic core 1
- Laser or light emitting diode 1 Consider 3
- specially designed jacket 1
- Small size and weight. 1



Light at less than critical angle is absorbed in jacket. 1

angle of incidance θ_i
angle of reflection θ_i

$n_1 \sin\theta_1 = n_2 \sin\theta_2$. 1

SECTION III.

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21. Parts of Stereo Demodulator:

1. Low pass filter (0-15KHz) 1
2. Band-pass filter (23-53 kHz) 1
3. Band-pass filter (19kHz) 1
4. Delay 1
5. :2 (frequency division) 1
6. 19 kHz. 1
7. Phase locked loop (PLL). 1
8. 38 kHz 1
9. DSB-SC L-R 1
10. L+R Signal 1
11. Balanced modulator 1
12. L-R Signal 1
13. VCO (voltage Controlled Oscillator) 1
14. Left output 1 (L+R)
15. Right output 1 (L-R)

15 marks.

22. From the given Bessel function row: $m_f = 1.0$

$J_0 = 0.77$ (1); $J_1 = 0.44$ (1); $J_2 = 0.11$ (1); $J_3 = 0.02$ (1)

We determine the powers of different frequency components:

$P_n = J_n^2(m_f)\, P_{trans}$ 1

$P_0 = J_0^2(m_f)\, P_{trans} = (0.77)^2 \times 1 \times 10 = 5.929\,W$ 1 (1) 15 marks.

$P_1 = J_1^2(m_f)\, P_{trans} = (0.44)^2 \times 1 \times 10 = 1.936\,W$ 1 (1)

$P_2 = J_2^2(m_f)\, P_{trans} = (0.11)^2 \times 1 \times 10 = 0.121\,W$ 1 (1)

$P_3 = J_3^2(m_f)\, P_{trans} = (0.02)^2 \times 1 \times 10 = 0.004\,W$ 1 (1)

The total Power in FM signal is the sum of all powers of ~~tot~~ freq. components:

$P_{tot} = P_0 + 2P_1 + 2P_2 + 2P_3$ 1

$= 5.929 + 2(1.936) + 2(0.121) + 2(0.004) = 10.051\,W$ 1