ETL – Telecommunication Systems

T129

Wednesday, 18/11/2015
08:30 – 11:30

WORKFORCE DEVELOPMENT AUTHORITY

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ADVANCED LEVEL NATIONAL EXAMINATIONS, 2015, TECHNICAL AND PROFESSIONAL TRADES

EXAM TITLE: **Telecommunication Systems**

OPTION: **Electronics and Telecommunication (ETL)**

DURATION: **3hours**

INSTRUCTIONS:

The paper is composed of **three (3) Sections**:

Section **I**. Nineteen **(19)** questions, all **compulsory.**	**55marks**	60
Section **II**. Five (5) questions, **Choose Three (3) only.**	**30marks**	13
Section **III**. Three (3) questions, **Choose only one (1).**	**15marks**	

85

158

Every candidate is required to strictly obey the above instructions. Punishment measures will be applied to anyone who ignores these instructions. 15

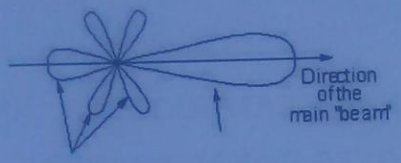
Section I. Nineteen (19) Compulsory questions. **55marks**

01. What is the role of microphone and earphone in telephone system? **2marks**

02. What are the two inseparable field components of electromagnetic waves? **2marks**

03. List out three major properties of electromagnetic waves. **3marks**

04. Complete the label of the Polar diagram for a yagi antenna shown below.



2marks

05. Most antennas and electromagnetic waves have two types of polarization. List them. **2marks**

06. What is the transmission medium for sound? **2marks**

07. Telephone is a duplex communications medium, what does mean? **2marks**

08. What are the four basic media for information transfer from one point to another in transmission systems? **4marks**

09. Show the main elements of a communication system using block diagram. **4marks**

10. What are the main three phases of PCM encoding (A/D conversion)? **3marks**

11. Differentiate half duplex from full-duplex. **4marks**

12. What is modulation? **3marks**

13. What are the four kinds of Amplitude Modulation techniques? **4marks**

14. Determine the developed three different types of colour picture tubes. **3marks**

15. How are the complementary colours in television colours produced? **4marks**

16. What are the basic wave propagation modes in radio communication? **3marks**

17. Describe the three compatible colour television systems. **3marks**

18. Identify the modulation techniques used in analog television transmissions for sound and video signals **3marks**

19. What are the factors that affect the propagation of radio waves? **2marks**

Section II. Answer any three (3) questions of your choice
(Do not choose more than three questions). 30marks

20. What are the advantages of FM over AM? What four basic functions must a receiver perform? **10marks**

21. Explain in detail about BPSK, QPSK, FSK and 8 phases PSK. **10marks**

22. Draw the push button keypad of Dual Tone Multi Frequency (DTMF) and explain what is DTMF signalling. **10marks**

23. The PAL TV system uses 625 interlaced scan lines occurring at a rate of 25 frames per second. The horizontal scanning rate is 15,625 Hz. About 80 percent of one complete horizontal scan is devoted to the displayed video, and 20 percent to the horizontal blanking. Assume that the horizontal resolution R_H is about 512 lines. Only about 580 horizontal scan lines are displayed on the screen. Calculate the bandwidth of the system and the vertical resolution R_V. **10marks**

24. **a)** An FM signal has a resting frequency of 105MHz and highest frequency of 105.03 MHz when modulated by a signal of frequency 5Khz, Determine:
    i. Frequency deviation,
    ii. Carrier suing,
    iii. Modulation index
    iv. Percent modulation
    v. Lowest frequency reached by the FM wave. **10marks**

    b) Identify and explain in order of signal processing the main elements of super heterodyne receiver. **10marks**

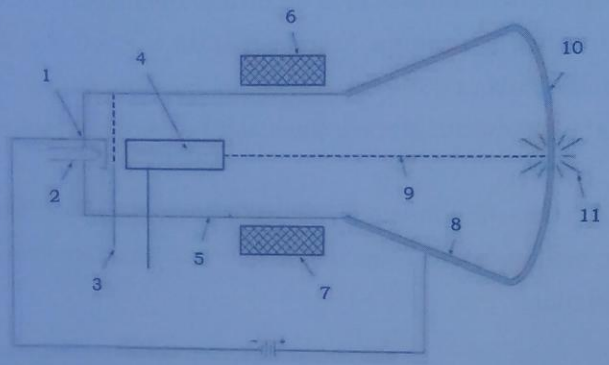
Section III. Answer any one (1) question of your choice

(Do not choose more than one question). **15marks**

25. With a net block diagram, explain all the elements of the fiber optic communication system and their roles. **15marks**

26. a) Identify different elements of a television picture tube (monochrome cathode-ray tube) represented by numbers (1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11) on the following diagram.

11marks



b) List the fundamental components of a DVD player. **4marks**

27. A frequency modulated voltage wave is given by the equation:

$e = 12\cos(6 \times 10^8 t + 5 \sin 1250\, t)$.

Find

(i) carrier frequency

(ii) signal frequency

(iii) modulation index

(iv) maximum frequency deviation

(v) power dissipated by the FM wave in 10-ohm resistor. **15marks**

SECTION I

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01. The microphone is used to convert the sound waves to electrical signals (1mark), which are sent through the telephone network to the other phone.

Earphone is used to convert the electrical signal to sound waves (1mark), in the phone's handset

2marks

02. The two field components of electromagnetic waves which are inseparable are:
- Electric field component ($\vec{E}$) 1mark
- magnetic field component ($\vec{B}$) 1mark

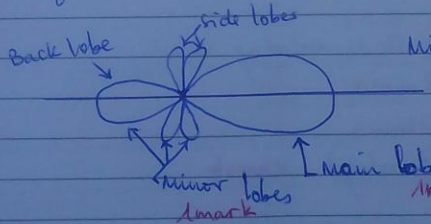
2marks

03. Major properties of electromagnetic waves are:
- Wavelength 1mark
- Frequency or BW 1mark
- velocity or speed 1mark
- Amplitude 1mark

Choose 3 only

3marks

04. The names of lobes are labeled as shown below:



Minor lobes = Back lobe + Side lobes.

2marks

05. Most antenna and electromagnetic waves have either:
- linear polarization (vertical or horizontal) 1mark
- Non-linear polarization (circular or elliptic) 1mark
(which can be right-hand or left-hand)

2marks

06. The transmission medium for sound is air (freespace). 2marks

2marks

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07. Telephones are duplex communications medium, because they allow people on both ends to talk simultaneously. 2mark

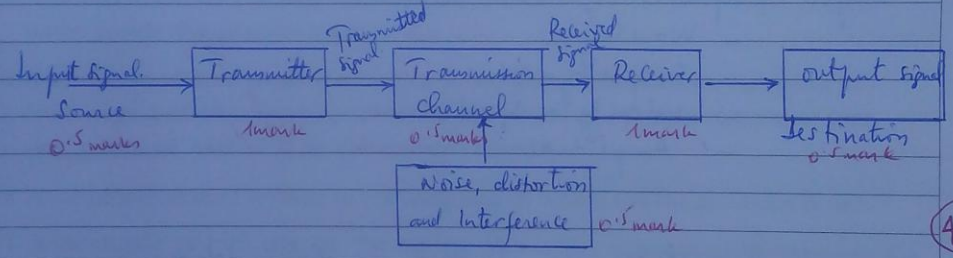
OR

Because it can transmit and receive at the same time 2marks

08. The four basic media used for information transfer from one point to another in transmission systems are:
- Copper cables (and twisted pair cables): LAN & phone subscribers 1mark
- Radio waves (wireless): used in cellular telephones & satellite 1mark
- optical fiber cables 1mark
- Freespace optics: such as infrared remote controllers 1mark

4marks

09. The main elements of a communication system are:

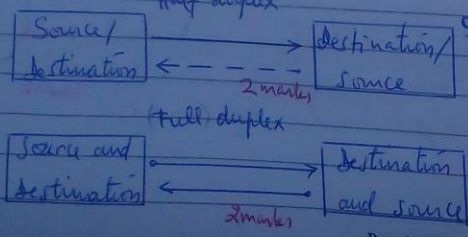


4marks

10. The main three phases of PCM encoding are:
- Sampling 1mark
- Quantizing 1mark
- Binary coding (encoding) 1mark

3marks

11. Difference between half duplex and full duplex.



OR

Signals are transmitted/received in one direction at a time. 2mark

examples: Email (data), SMS, radio systems (walkie talkie)

OR

Signals are transmitted/and received in both direction at the same time 2marks

eg: Telephone

4marks

12. Modulation:
It is the process by which some characteristics of the carrier signal (ie high frequency signal) is varied in accordance with message signal (ie modulating signal or low frequency signal). /3 marks

OR

It is the technique of superimposing the message signal on the carrier. /3 marks

3marks

13. The four kinds of Amplitude modulation techniques are:

- DSB-SC AM : Double Side Band Suppressed Carrier AM 1mark
- DSB-LC : Double Sideband large carrier modulation or Conventional AM 1mark
- SSB : Single Sideband AM 1mark
- VSB : Vestigial Sideband AM 1mark

4marks

14. The three different types of color picture developed are:

- Delta-gunn color picture tube 1mark
- Guns in line or Precision in-line (PIL) color picture tube 1mark
- Single gun or Trinitron color picture tube 1mark

3marks

15. The complementary colors in color TV are produced by:

either - additive mixing. 1 mark

Red + Green = Yellow 1mark
Red + Blue = magneta 1mark
Blue + Green = cyan 1mark

OR - Subtractive mixing 1mark

white - Blue = Yellow 1mark
white - green = magneta 1mark
white - red = cyan 1mark

4marks

16. The basic wave propagation modes in radio communication are:
- Ground wave or surface wave propagation (direct wave + ground wave + surface wave). 1mark
- Sky wave propagation 1mark
- line of sight propagation (LOS) or space wave 1mark
- Non-LOS propagation 1mark

Any three

3marks

17. The three compatible color TV systems are:
- NTSC : National Television System Committee 1mark
- PAL : Phase Alternating by Lines 1mark
- SECAM : Sequential color with memory 1mark

3marks

18. Analog TV transmissions use:
- VSB modulation (AM) for picture signal. 1½marks
- FM or digital QPSK for voice signal. 1½marks

3marks

19. The factors that affect the propagation of radio waves are:
- curvature of earth 0.5 marks
- Earth's magnetic field 0.5 marks
- Frequency of the signal 0.5 marks
- Plane earth reflection 0.5 marks
- climate change 0.5 marks
- Human activities. 0.5 marks

Choose four

2marks

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20. * Advantages of FM over AM

- The amplitude of FM is constant. It is independent of depth of modulation. Hence transmitter power remains constant in FM whereas it varies in AM. 1 mark

$P_{FM} > P_{AM}$

- Since amplitude of FM is constant, the noise interference is minimum in FM. Any noise superimposing amplitude can be removed with the help of amplitude limiter. whereas it is difficult to remove amplitude variations due to noise in AM. 1 mark

- The depth of modulation has limitation in AM, But in FM the depth of modulation can be increased to any value by increasing the deviation. This does not cause any distortion in FM signal. 1 mark

- Since guard bands are provided in FM, there is less possibility of adjacent channel interference. 1 mark.

- Since space waves are used for FM, the radius of propagation is limited to line of sight. Hence it is possible to operate several independent transmitters on same frequency with minimum interference. 1 mark

- Since FM uses UHF and VHF ranges, the noise interference is minimum compared to AM which uses MF and HF ranges.

- Equipments are cheap ✓ 1 mark Compared to AM. 1 mark

choose six only

* Basic functions that a receiver must perform:

- Reception/Antenna 1 mark
- Selection 1 mark
- Detection (demodulation) 1 mark
- Reproduction (Amplification) 1 mark

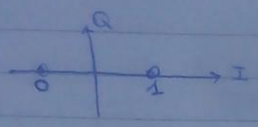
10 marks

21.

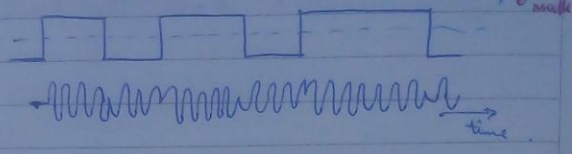
* BPSK: Binary Phase Shift keying 1mark

Two output phases are possible for a single carrier frequency. 1mark
One output phase represents logic 1 and the other logic 0 (180°) 0.5 mark

OR



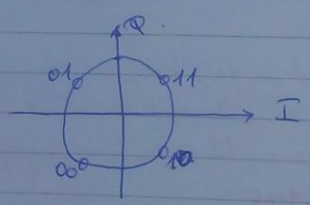
OR



* QPSK: Quadrature or 4 phase shift keying. 0.5 mark

- With QPSK, four output phases are possible for a single carrier frequency. Two bits are clocked into the bit splitter.
- After both bits have been serially inputted, they are simultaneously parallel outputted. 0.5 mark
- One bit is directed to the I channel and the other to the Q channel. 0.5 mark
- Two bits are modulated at once, selecting one of four possible carrier phase shifts (0°, 90°, 180°, 270°) 0.5 mark

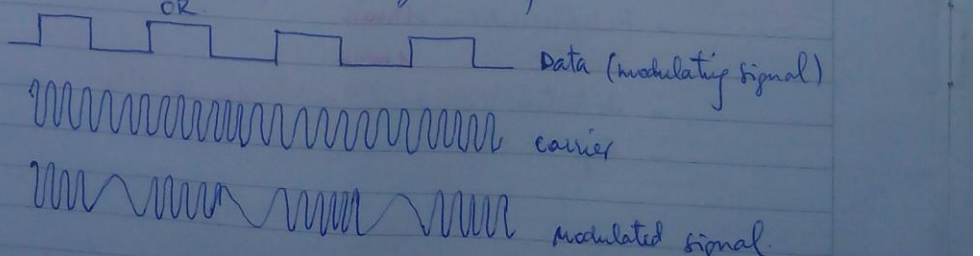
OR



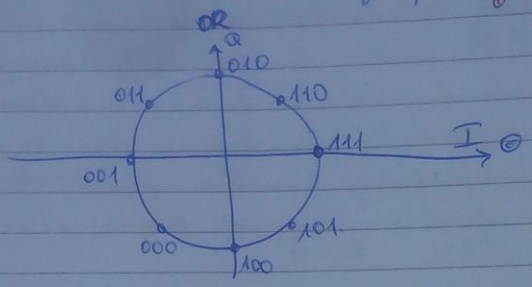
* FSK: Frequency shift keying 1mark

It is a form of constant amplitude angle modulation similar to conventional frequency modulation except that the modulating signal is a binary signal that varies between two discrete voltage levels rather than a continuously changing analog waveform. 1.5 marks

OR



* 8 phase PSK - 8 phase shift keying 1mark
It is a M-ary encoding technique where M = 8.
With an 8PSK modulator, there are eight possible output phases. 1mark
To encode eight output phases, the incoming bits are considered in groups of three bits, called tribits. 0.5 mark



10marks

22. Four-Row by Four-column Keypad matrix Push button :

Column (High group) frequencies
1209 Hz to 1mark 1336 Hz 0.5mark 1477 Hz 0.5mark 1633 Hz 0.5mark

1	ABC 2	DEF 3	A
GHI 4	JKL 5	MNO 6	B
PRS 7	TUV 8	WXY 9	C
*	0	#	D

697 Hz 0.5 mark
770 Hz 0.5 mark
852 Hz 0.5 mark
941 Hz 0.5 mark
Row (Low group) frequencies

4 marks
(optional)

DTMF Signaling :
It is a group a signalling method that uses a mixture of two pure tone sounds. 2marks

10marks

23. The time for one horizontal scan is $\frac{1}{15625} = 64\mu s$ 1.5 mark

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About 80% of this is devoted to the video, or $0.8 \times 64 = 51.2\mu s$ 1.5 marks

If the horizontal resolution is 512 lines, then the time for one line is $\frac{51.2}{512} = 0.1\mu s$. 2 marks

Two lines equals 1 period, or $2 \times 0.1 = 0.2\mu s$ 1.5 mark

Converting this to frequency gives the approximate bandwidth

$$BW = \frac{1}{0.2\mu s} = \frac{1}{0.2 \times 10^{-6}} = 5\,MHz$$ 1.5 mark

The vertical resolution

$$R_V = 0.8 \times NL = 0.8 \times 580 \text{ lines} = 464 \text{ lines}$$

↑ number of lines

2 marks

10 marks

24.

A) i) Frequency deviation = 105.03 − 105 = 30 KHz 1 mark

ii) Carrier swing = 2 × 30 = 60 KHz 1 mark

iii) Modulation index = $\frac{30}{5} = 6$ 1 mark

iv) Percent modulation = $\frac{30}{75} \times 100\% = 40\%$ 1 mark

v) lowest frequency reached by FM wave = 105 − 0.03 = 104.97 MHz 1 mark

B) The main sections of superheterodyne receiver are:

- RF section
- Mixer/converter section
- IF section
- Audio detector section
- Amplifier section

- RF Section: Consists of preselector and an amplifier stage. 0.5mark
The primary purpose of the preselector is to provide enough initial bands limiting to prevent a specific unwanted radio frequency, called image frequency. 0.5mark

- Mixer / converter: is a nonlinear device and its purpose is to convert radio frequencies to intermediate frequencies. 0.5mark 0.5mark

- IF Section: Consists of a series of IF amplifiers and bandpass filters (often called IF strip). 0.5mark
The receiver gain and selectivity is achieved in IF section. 0.5mark

- Detector (or Demodulator) Section: its purpose is to convert the IF signals back to the original source information 0.5mark 0.5mark

- Audio Amplifier section: comprises several cascaded audio amplifiers and one or more speakers. 0.5mark 0.5mark

10marks

26 A) Elements of a TV picture tube (monochrome CRT):

1. Cathode emits electrons 1mark
2. Heater filament heats cathode 1mark
3. Control grid varies intensity + bias voltage 1mark
4. Electron gun focuses the beam. 1mark
5. Glass neck/cover 1mark
6. Magnetic deflection coils (yoke) deflect beam 1mark
7. Magnetic deflection coils 1mark
8. Metallic coating inside / Anode terminal / High voltage terminal 1mark
9. Narrow electron beam 1mark
10. Phosphor coating glows when struck by electrons / glass plate 1mark
11. Light spot / beam (images) 1mark.

B) Fundamental components of a DVD player:

- Drive motor to spin the disc 1mark
- A laser and lens system to focus in on bumps and read them (optical system) 1mark
- Tracking mechanism that can move the laser assembly so that the lasers beam can follow the spiral track. 1mark
- Electronic circuitry (PCB) 1mark

(15marks)

27. The given FM voltage wave is given by:

$$e = 12\cos(6\times10^8 t + 5\sin 1250t)$$

The standard FM voltage wave (equation) is:

$$e = E_c \cos(\omega_c t + m_f \sin \omega_s t)$$

i) Carrier frequency, $f_c = \frac{\omega_c}{2\pi} = \frac{6\times10^8}{2\pi} = 103.12\,MHz$ (1mark, 2marks)

ii) Signal frequency, $f_s = \frac{\omega_s}{2\pi} = \frac{1250}{2\pi} = 199\,Hz$ (1mark, 2marks)

iii) Modulation index, $m_f = 5$ 3marks

iv) Max. frequency deviation, $\Delta f = m_f \times f_s = 5\times199 = 995\,Hz$ (1mark, 2marks)

v) Power dissipated, $P = \frac{E_{rms}^2}{R} = \frac{(12/\sqrt{2})^2}{10} = 7.2\,W$ (1mark, 2marks)

(15marks)

⚠ The question was asked wrongly where the carrier frequency should not be less than the frequency of signal.