Kafrelsheikh University - Faculty of Engineering			
Course	Digital Communications	Date	27/5/2018
Time	3 Hours	Mark	70
Students	3rd year Computer and systems		

This exam measures ILOs no.: a.13, a.15, b.16

Answer all the following questions:

Clarify your answer with the suitable diagrams.

Q1. Compare Between The GEO, MEO and LEO orbits of satellites. (7 Marks)

ANS:

Geostationary or geosynchronous earth orbit (GEO)

GEO satellites are synchronous with respect to earth. Looking from a fixed point from Earth, these satellites appear to be stationary. These satellites are placed in the space in such a way that only three satellites are sufficient to provide connection throughout the surface of the Earth (that is; their footprint is covering almost 1/3rd of the Earth). The orbit of these satellites is circular. There are three conditions which lead to geostationary satellites. Lifetime expectancy of these satellites is 15 years.

1) The satellite should be placed 37,786 kms (approximated to 36,000 kms) above the surface of the earth.

2) These satellites must travel in the rotational speed of earth, and in the direction of motion of earth, that is eastward.

3) The inclination of satellite with respect to earth must be 0^0.

These satellites are used for TV and radio broadcast, weather forecast and also, these satellites are operating as backbones for the telephone networks.

Low Earth Orbit (LEO) satellites:

These satellites are placed 500-1500 kms above the surface of the earth. As LEOs circulate on a lower orbit, hence they exhibit a much shorter period that is 95 to 120 minutes. LEO systems try to ensure a high elevation for every spot on earth to provide a high quality communication link. Each LEO satellite will only be visible from the earth for around ten minutes.

These satellites are mainly used in remote sensing and providing mobile communication services (due to lower latency).

- **Medium Earth Orbit (MEO) satellites:**
- **MEOs can be positioned somewhere between LEOs and GEOs, both in terms of their orbit and due to their advantages and disadvantages. Using orbits around 10,000 km, the system only requires a dozen satellites which is more than a GEO system, but much less than a LEO system. These satellites move more slowly relative to the earth's rotation allowing a simpler system design (satellite periods are about six hours). Depending on the inclination, a MEO can cover larger populations, so requiring fewer handovers.**

Q2. Compare between optical Fiber, Twisted Pair and Coaxial cables. (7 Marks)

ANS:

	Optical Fiber	Coaxial Cable	Twisted Pair
Bandwidth	Very High	Medium	Low
Interference	Immune	Not Immune	Very weak against Interference
Cost	Very High	Medium	Very low
Distance	In the range of hundreds to thousands of KM	In the range of tens of KM	Less than 1 KM
Installation Difficulty	Very hard	Easy	Very Easy

Q3. Calculate the epoch day of 22 hours 56 minutes and 52.88 seconds of the 324th day of the year. (7 Marks)

***Solution*:**

52.88/60 = 0.881344 minutes

56.881344/60=0.948022 hours

22.948022/24=0.95616765 Days

epoch day is 324.95616765

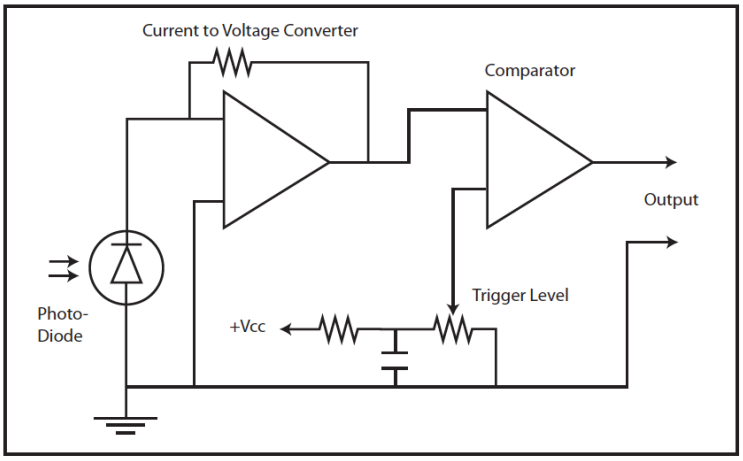
Q4. Write about the different generations of the PBX. (7 Marks)

- **First Generation:**
  - **Analog switching and transmission .**
  - **Stored program control**
- **Second Generation:**
  - **Analog transmission**
  - **Some digital switching**
  - **Blocking architecture providing**
  - **limited data transmission capability**
- **Third Generation:**
  - **Fully digital switching and transmission .**
-
  - **Non blocking**
  - **Voice and data capability.**
- **Fourth Generation:**
  - **Fully digital switching and transmission**
  - **Distributed architecture**
  - **LAN-based**
- **Fifth Generation:**
  - **Broadband digital switching and transmission via fiber optics.**
  - **Fully integrated voice, data, and full-motion video.**
  - **Possibly integrated optical switching.**

Q5. Explain in detail, with the aid of graphs, how the digital optical receiver works. (7 Marks)

Figure 11 is a functional diagram of a simple digital optical receiver. As in the case of the analog receiver, the first stage is a current-to-voltage converter. The output of this stage, however, is fed to a voltage comparator, which produces a clean, fast rise-time digital output signal. The trigger level adjustment, when present, is used to "touch up" the point on the analog signal where the comparator switches. This allows the symmetry of the recovered digital signal to be trimmed as accurately as desired.

Figure 11 - Basic Digital Fiber Optic Receiver



Q6. What are the advantages of Fiber Optic Systems? (7 Marks)

Fiber optic transmission systems – a fiber optic transmitter and receiver, connected by fiber optic cable – offer a wide range of benefits not offered by traditional copper wire or coaxial cable. These include:

1- The ability to carry much more information and deliver it with greater fidelity than either twisted pair wire or coaxial cable.

2- Fiber optic cable can support much higher data rates and at greater distances, than coaxial cable, making it ideal for transmission of serial digital data.

3- The fiber is totally immune to virtually all kinds of interference, including lightning, and will not conduct electricity. It can therefore come in direct contact with high voltage electrical equipment and power lines. It will also not create ground loops of any kind.

4- As the basic fiber is made of glass, it will not corrode and is unaffected by most chemicals. It can be buried directly in most kinds of soil or exposed to most corrosive atmospheres in chemical plants without significant concern.

5-Since the only signal in the fiber is light, there is no possibility of a spark from a broken fiber. Even in the most explosive of atmospheres, there is no fire hazard, and no danger of electrical shock to personnel repairing broken fibers.

6- Fiber optic cables are virtually unaffected by outdoor atmospheric conditions, allowing them to be lashed directly to telephone poles or existing electrical cables without concern for extraneous signal pickup.

7- A fiber optic cable, even one that contains many fibers, is usually much smaller and lighter in weight than a wire or coaxial cable with similar information carrying capacity. It is easier to handle and install, and uses less duct space. (It can frequently be installed without ducts.)

8- Fiber optic cable is ideal for secure communications systems because it is very difficult to tap but very easy to monitor. In addition, there is absolutely no electrical radiation from a fiber.

Q7. Calculate the antenna gain in dB for a parabolic reflective antenna with a diameter of 3m and operating at 8 GHz. (G=7A/ λ^2). (7 Marks)

ANS: $\lambda = \frac{c}{f} = \frac{3\times10^8}{8\times10^9} = 0.0375\ m$

A=$\pi r^2 = 3.14 \times 1.5^2 = 7.065\ m^2$

G=7A/ $\lambda^2 = \frac{(7\times7.065)}{0.0375^2} = 35168$

G=10 log (35168)**=45.46 dB**

Q8. Find the relation between the frequency of the rotation and the radius of the satellite orbit. (7 Marks)

- **The attractive force *Fg* of the earth due to gravity equals**
  - $Fg = m.g.\left(\frac{R}{r}\right)^2$
- **The centrifugal force *Fc* trying to pull the satellite away equals:**
  - $Fc = m.r.\omega^2$

- **The variables have the following meaning: m is the mass of the satellite; R is the radius of earth with R = 6,370 km;**
- **r is the distance of the satellite to the centre of the earth; g is the acceleration of gravity with g = 9.81 m/s^2; ω is the angular velocity with ω = $2\pi f$, f is the frequency of the rotation.**
- **To keep the satellite in a stable circular orbit, the following equation must hold: Fg = Fc, i.e., both forces must be equal. Looking at this equation the first thing to notice is that the mass m of a satellite is irrelevant (it appears on both sides of the equation). Solving the equation for the distance r of the satellite to the centre of the earth results in the following equation:**
  - $r = (g.\frac{R^2}{(2\pi f)2})^{1/3}$

Q9. Explain the following Entropy encoding techniques: (7 Marks)

a- Run-length encoding.
b- Statistical encoding
c- Color look up table.

1. **ANS: run-length encoding. In many kinds of data, strings of repeated symbols (bits, numbers, etc.) are common. These can be replaced by a special marker not otherwise allowed in the data, followed by the symbol comprising the run, followed by how many times it occurred. If the special marker itself occurs in the data, it is duplicated (as in character stuffing).**
   - **For example, consider the following string of decimal digits:**
   - **3150000000000084587111111111111635467400000000000000000000065**
   - **If we now introduce A as the marker and use two-digit numbers for the repetition count, we can encode the above digit string as**
   - **315A01284587A11316354674A02265**
   - **Here run-length encoding has cut the data string in half.**
   - **Runs are common in multimedia. In audio, silence is often represented by runs of zeros. In video, runs of the same color occur in shots of the sky, walls, and many flat surfaces. All of these runs can be greatly compressed.**
2. **statistical encoding. By this we mean using a short code to represent common symbols and long ones to represent infrequent ones. Morse code uses this principle, with E being . and Q being --.- and so on.**
3. **(Color Look Up Table) encoding. Consider an image using RGB encoding with 3 bytes/pixel. In theory the image might contain as many as 2^{24} different color values. In practice, it will normally contain many fewer values, especially if the image is a cartoon or computer-generated drawing, rather than a photograph.**

Suppose that Only 256 color values are actually used. A factor of almost three compression can be achieved by building a 768-byte table listing the RGB values of the 256 colors actually used, and then representing each pixel by the index of its RGB value in the table.

Q10. A Multi parity check code Block (63,57) is received from a TV frame. The parity bits are in the locations 31, 47, 55, 59, 61, 62. Explain how this block will be corrected at the receiver if the bit at location 11 was received in error. (7 Marks)

ANS: Using the rules of parity checking:

P1=0 because bit on 11 is in error.

P2=1

P3=0 because bit on 11 is in error.

P4=P5=1

P1P2P3P4P5=01011 which is the position of the bit no 11.

Good Luck and Best Wishes ***Dr. Ibrahim Elashry***