Part 1: (34 points - 2 points for each problem)

(D) 1. 802.15 falls into the category of:
   (A) fixed and wired (B) mobile and wired (C) fixed and wireless (D) mobile and wireless

(B) 2. Which band is used for cellular phone systems?
   (A) VHF (B) UHF (C) SHF (D) none of above

(A) 3. An 8-bit byte with binary value 10001010 is to be encoded using an even-parity Hamming code. What is the binary value after encoding?
   (A) 101000001010 (B) 111000001010 (C) 101000001011 (D) none of above

(D) 4. Using the divisor polynomial $x^3 + x + 1$ for CRC, what frame will be transmitted for the data $M = 110011001$?
   (A) 110011001110 (B) 110011001110 (C) 110011001100 (D) none of above

(C) 5. The antenna size for a GSM device which uses the 1800 MHz frequency band is
   (A) 8.33 cm (B) 2.08 cm (C) 4.16 cm (D) none of above

(D) 6. Which is not a common security problems that may rise in wireless networks?
   (A) Replay attacks (B) Tunnel hijacking (C) FA can be a malicious node. (D) none of above

(B) 7. The propagation effect that occurs when a radio wave hits an impenetrable object and bends at the edges of the object.
   (A) blocking (B) diffraction (C) reflection (D) refraction

(D) 8. Which 802.16 service is intended for transmitting compressed multimedia?
   (A) constant bit rate service (B) non-real-time variable bit rate service (C) best-efforts service (D) none of the above

(A) 9. Which modulation is used in both 802.11b and 802.16?
   (A) QPSK (B) QAM-16 (C) QAM-64 (D) none of the above

(B) 10. Which is not the advantage of cellular systems?
   (A) higher capacity (B) robustness (C) less transmission power (D) none of the above

(C) 11. The maximum data rate over a 1 MHz channel whose signal to noise ratio is 20 dB.
   (A) 2.16 Mbps (B) 3.33 Mbps (C) 6.66 Mbps (D) none of above

(C) 12. Which statement about Bluetooth is incorrect?
   (A) It operates in the ISM band.
   (B) Two kinds of links (ACL and SCO) exist.
   (C) Bluetooth 2.0 can offer the transfer rate up to 12 Mbps.
   (D) none of above

(B) 13. Which is not the reason why the reverse tunnelling is required in Mobile IP?
   (A) firewall (B) authentication (C) TTL (D) none of the above

(C) 14. Which defines an extension of the 802.11 standard for QoS?
   (A) 802.11c (B) 802.11d (C) 802.11e (D) 802.11h

(A) 15. Which UMTS technology is used in FOMA?
   (A) IMT-DS (B) IMT-TC (C) IMT-MC (D) none of the above

(D) 16. Which is not a WLL system? (A) DECT (B) PACS (C) E-TDMA (D) none of above

(A) 17. Which statement is false?
   (A) HSCSD is Packet-switched. (B) GPRS offers data rates up to 171.2 Kbps.
   (C) EDGE can achieve a higher transfer rate than GPRS. (D) none of above
Part 2: (66 points)

1. (12 points) Briefly explain these terminologies. If they are acronyms, also write what they stand for.
   (a) **PLCP** Physical Layer Convergence Protocol (PLCP) is a protocol that provides a uniform abstract view for the MAC sublayer.
   (b) **MMDS** Multichannel Multipoint Distribution Service (MMDS) is a broadband wireless service.
   (c) **HAWAII** Handoff Aware Wireless Access Internet Infrastructure (HAWAII) is a mechanism that handles local movement (intra-domain) of mobile nodes.
   (d) **OFDM** Orthogonal Frequency Division Multiplexing, an FDM modulation technique for transmitting large amounts of digital data over a radio wave.

2. (a) (3 points) Describe the problems when CSMA/CD is applied to wireless networks.
   (b) (5 points) What method could solve the problems? Describe how it works.
   (a) Two problems occur:
      i. Hidden and exposed terminals - Carrier sensing may fail to detect another terminal or detect a terminal outside the interference range.
      ii. Near and far terminals - The local signal might drown out the remote transmission.
   (b) When a station is ready for transmission, it sends a request to send (RTS) frame to the receiver and waits to receive a clear to send (CTS) frame from the receiver. As a result, all stations within the range will refrain from transmitting a data frame. Once CTS is received, the sender can send packets. In this way, the CTS frame can be heard by the hidden terminals and the medium for future use by other sending terminal is reserved. The exposed terminal won’t react to RTS and doesn’t receive CTS because the exposed terminal is not the receiver. The near and far terminals could be solved in the similar way.

3. (a) (2 points) Consider an area of 1260 square Km covered by a cellular network. If each user requires 200 KHz for communication, and the total available spectrum is 40 MHz, how many users can be supported without frequency reuse?
   (b) (3 points) If cells of area 30 square Km are used, how many users can be supported with cluster sizes of 7?
   (a) 40/0.2 = 200 users.
   (b) There are 1260/30 = 42 cells. Each cell can support 200/7 users. Total number of users that can be supported is 42 x 200/7 = 1200 users.

4. Consider a WLL system using FDMA and 64-QAM modulation. Each channel is 200 KHz and the total bandwidth is 20 MHz, used symmetrically in both directions. Assume that the BS employs 120-degree beam-width antennas. Given spectral efficiency of 64-QAM is 5 bps/Hz. Find
   (a) (3 points) The number of subscribers supported per cell.
   (b) (3 points) The total data capacity, assuming 40 cells.
   (a) The number of users supported per sector is 20/(0.2 + 0.2) = 50 users. The number of subscribers supported per cell is 50 x 360/120 = 150 users.
   (b) 20 MHz x 5 bps/Hz x 3 x 40 = 12 Gbps (6 Gbps for uplink and 6 Gbps for downlink)

5. (a) (2 points) What is digital modulation?
   (b) (2 points) What is analog modulation?
   (c) (3 points) Why a baseband signal cannot be directly transmitted in a wireless system?
   (a) Digital Modulation is that the digital data (0 and 1) is translated into an analog signal (baseband signal).
   Digital modulation is required if digital data has to be transmitted over a medium that only allows for analog transmission.
   (b) Analog modulation shifts the center frequency of the baseband signal generated by the digital signal up to the radio carrier.
   (c) There are 3 main reasons why a baseband signal cannot be directly transmitted in a wireless system.
      i. Antennas: An antenna must be the order of magnitude of the wavelength signal in size to be effective.
      ii. Frequency division multiplexing: Using only baseband transmission, FDM could not be applied.
      iii. Medium characteristics: Path loss, penetration of obstacles, reflection, scattering and diffraction. All the effects depend on the wavelength of a signal.
6. (a) (2 points) What is a good code for CDMA?
   (b) Consider a sender A wants to send the data bit 0 with key = 011010. Consider a sender B wants to send the data bit 1 with key = 101001. Assume we code a binary 0 as -1, a binary 1 as +1. Both signals are transmitted at the same time. The noise to the transmitted signal is (-2, +2, 0, -2, 0, +2).
   i. (3 points) What signal is received at a receiver?
   ii. (3 points) Can the data sent by A and B be recognized?

   (a) A good code for CDMA should have a good autocorrelation and should be orthogonal to other codes.
   i. \( A_s = -1 \times (-1, +1, +1, -1, +1, -1) = (+1, -1, -1, +1, -1, +1) \)
   \( B_s = +1 \times (+1, -1, +1, -1, -1, +1) = (+1, -1, +1, -1, -1, +1) \)
   \( S = A_s + B_s + N = (+2, -2, 0, 0, -2, +2) + (-2, +2, 0, -2, 0, +2) = (0, 0, -2, -2, +4) \)
   (0, 0, 0, -2, -2, +4) is received by a receiver.
   ii. \( A_r = (0, 0, 0, -2, -2, +4) \times (-1, +1, +1, -1, +1, -1) = 2 - 2 - 4 = -4 < 0 \Rightarrow 0 \)
   \( B_r = (0, 0, 0, -2, -2, +4) \times (+1, -1, +1, -1, -1, +1) = 2 + 2 + 4 = 8 > 0 \Rightarrow 1 \)
   The data sent by A can be recognized as 0. The data sent by B can be recognized as 1.

7. (a) (3 points) Describe three MAC services provided by the IEEE 802.11 that are not provided in 802.3.
   (b) (4 points) Describe 4 types of device specified in a piconet.
   (c) (3 points) Describe two types of mobilities that are applicable in TIMIP.

   (a) • Power conservation: When the station is not active for some time, it will go to a power save mode.
   • Mobility: The mobile station can move from one network to another.
   • Security and confidentiality: 802.11i specify the security measures in 802.11.

   (b) • Master nodes determine hopping pattern.
   • Slave nodes have to synchronize with master nodes.
   • Parked nodes are not active and in the low power mode.
   • Standby nodes do not participate in the piconet.

   (c) • Macro-mobility deals with the inter-domain movement of mobile nodes.
   • Micro-mobility handles local movement (intra-domain) of mobile nodes.
8. (10 points) Complete the following TCP Midlet code (TCPClient.java) and Java server code (TCPEchoServer.java). Each time the client connects to the server the server will generate a new thread to echo the message back to the client.

```java
import javax.microedition.midlet.*;
import javax.microedition.io.*;
import javax.microedition.lcdui.*;
import java.io.*;

public class TCPCClient extends MIDlet implements CommandListener {

    private Form f;
    private StringItem si;
    private TextField tf;
    private Command sendCommand = new Command("Send", Command.ITEM, 1);
    private Command exitCommand = new Command("Exit", Command.EXIT, 1);
    DataInputStream is;
    DataOutputStream os;
    SocketConnection sc;

    public TCPCClient() {
        f = new Form("Socket Client");
        si = new StringItem("Status:", " ");
        tf = new TextField("Send:", ",", 30, TextField.ANY);
        f.append(si);
        f.append(tf);
        f.addCommand(exitCommand);
        f.addCommand(sendCommand);
        f.setCommandListener(this);
    }

    public void startApp() {
        Display.getDisplay(this).setCurrent(f);
        try {
            sc = (SocketConnection) Connector.open("socket://localhost:6789");
            si.setText("Connected to server");
            is = sc.openDataInputStream();
            os = sc.openDataOutputStream();
            while (true) {
                si.setText("Message received: " + is.readUTF());
            }
        } catch (IOException ioe) {} 
    }

    public void commandAction(Command c, Displayable s) {
        if (c == sendCommand) {
            try {
                si.setText("Message sent: " + tf.getString());
                os.writeUTF(tf.getString());
            } catch (IOException ioe) {} 
        }
        if (c == exitCommand) {
            notifyDestroyed();
            destroyApp(true);
        }
    }

    public void pauseApp() {}
    public void destroyApp(boolean unconditional) {}
}
```
import java.net.*;
import java.io.*;

public class TCPEchoServer {
    public static void main (String args[]) throws IOException {
        int serverPort = args.length < 1 ? 6789 : Integer.parseInt(args[0]);
        ServerSocket replySocket = new ServerSocket(serverPort);
        while(true) {
            Socket clientSocket = replySocket.accept();
            Coordination c = new Coordination(clientSocket);
        }
    }
}

class Coordination extends Thread {
    DataInputStream in;
    DataOutputStream out;

    public Coordination (Socket requestSocket) throws IOException {
        in = new DataInputStream(requestSocket.getInputStream());
        out =new DataOutputStream(requestSocket.getOutputStream());
        this.start();
    }

    public void run() {
        try {
            byte buffer[] = new byte[1024];
            in.read(buffer);
            System.out.println("Received: " + new String(buffer));
            out.write(buffer);
        } catch(IOException e) {System.out.println("IO:"+e.getMessage());}
    }
}