宁波大学2017年博士研究生招生考试初试试题(B卷)

(答案必须写在考点提供的答题纸上)

科目代码： 3807 科目名称： 数字通信

一、填空（16分，每空2分）

1、QAM信号的解调通常采用（ ）相干解调。

2、设在$500\mu s$内传输1024个二进制码元，则码元传输速率是（ ）。

3、如果理想MPSK数字调制传输系统的带宽为10kHz，则该系统无码间干扰最大信息传输速率为（ ）b/s。

4、数字通信系统的有效性指标有（ ）和（ ），可靠性指标有（ ）。

5、信号在随参信道中传输时，产生频率弥散的主要原因是( )，宽频带信号在短波电离层反射信道中传输时，可能遇到的主要衰落类型是（ ）。

二、选择题（14分，每空2分）

从下面所列答案中选择出最合理的答案，填入后面的答题中。每个空格只能选一个答案，不排除某一个答案被多次选择的可能性。

示例题：3+2= （ r ）， 2×0= （ q ）

(a) 2DPSK　(b) 2ASK　(c) 2PSK　(d) 2FSK

(e) 慢　(f)快　(g) 倒π现象　(h) 相位错移

(i) $\log_2 M$kb/s　(j) $10\log_2 M$kb/s　(k) 1　(l) 2

(m) 时域均衡　(n) 循环稳定　(o) 高　(p)5

(q) 0　(r) 5　(s) 9

1、BPSK 信号在接收端因为载波同步系统中的分频，可能产生载波相位状态转移，发生对信号的错误解调，这种现象称为（ ）。

2、对于传输信道所引入的码间干扰，一种基本的解决方法是采用（ ）。

3、如果升余弦滚降系统的滚降系数α越小，则相应的系统总的冲激响应 x (t)的拖尾衰减越（ ）。

4、2DPSK，2ASK，2PSK，2FSK，采用相干解调时，抗信道加性高斯白噪声性能从好到坏排列顺序是（ ），（ ），（ ），（ ）。

三、解答题

已知某(7, 3)循环码的生成多项式是$g(x)=x^4+x^3+x^2+1$。

(a)请画出系统码的编码器框图；

(b)写出信息 100、010、001 对应的编码结果；

(c)写出该码的生成矩阵。

（10 分）

四、Translate the following from English into Chinese. And，say something about your understanding of digital communications, communication system, or information system. (60 分)

Millimeter wave communications span a wide frequency range from 30 GHz to 300 GHz offering exciting new opportunities to utilize the spectrum for broadband applications. A maximum data rate of 6.756 Gbps is achievable using suitable modulation and coding schemes under the ambit of the IEEE 802.11ad standard developed for 60 GHz indoor communications. This has spurred further interest to explore other frequencies in the millimeter wave spectrum such as the frequency bands in the 28–38 GHz and 70–90 GHz range, particularly for outdoor applications in 5G cellular mobile systems, local multipoint distribution services, cellular backhaul and intra-cell communication systems. Moreover, the Federal Communications Commission in the United States recently increased the maximum outdoor emission power limits for operation in the unlicensed millimeter wave band from 57 GHz to 64 GHz. This development is expected to provide the impetus for further research to harness the 60 GHz band for new applications with improved system link margin. The gain realized through antenna beamforming can compensate for the excessive path and penetration losses at millimeter wave frequencies. The millimeter wave channel characteristics, to a large extent, dictate the choice of physical layer and medium access control layer schemes as well as the hardware implementation. From this perspective, multiple antenna technology is a key enabler to efficiently utilize the millimeter wave band as it can increase the link capacity by employing directional communication.

Orthogonal frequency division multiplexing (OFDM) has become a popular technique for transmission of signals over wireless channels. OFDM has been adopted in several wireless standards such as digital audio broadcasting (DAB), digital video broadcasting (DVB-T), the IEEE 802.11a local area network (LAN) standard and the IEEE 802.16a metropolitan area network (MAN) standard. OFDM is also being pursued for dedicated short-range communications (DSRC) for road side to vehicle communications and as a potential candidate for fourth-generation (4G) mobile wireless systems.

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科目代码 ： **3807** 科目名称： 数字通信

OFDM converts a frequency-selective channel into a parallel collection of frequency flat subchannels. The subcarriers have the minimum frequency separation required to maintain orthogonality of their corresponding time domain waveforms, yet the signal spectra corresponding to the different subcarriers overlap in frequency. Hence, the available bandwidth is used very efficiently. If knowledge of the channel is available at the transmitter, then the OFDM transmitter can adapt its signaling strategy to match the channel. Due to the fact that OFDM uses a large collection of narrowly spaced subchannels, these adaptive strategies can approach the ideal water pouring capacity of a frequency selective channel. OFDM is a block modulation scheme where a block of information symbols is transmitted in parallel on subcarriers. The time duration of an OFDM symbol is times larger than that of a single carrier system. An OFDM modulator can be implemented as an inverse discrete Fourier transform (IDFT) on a block of information symbols followed by an analog-to-digital converter (ADC). To mitigate the effects of inter-symbol interference (ISI) caused by channel time spread, each block of IDFT coefficients is typically preceded by a cyclic prefix (CP) or a guard interval consisting of samples, such that the length of the CP is at least equal to the channel length. Under this condition, a linear convolution of the transmitted sequence and the channel is converted to a circular convolution. As a result, the effects of the ISI are easily and completely eliminated. Moreover, the approach enables the receiver to use fast signal processing transforms such as a fast Fourier transform (FFT) for OFDM implementation. Similar techniques can be employed in single-carrier systems as well, by preceding each transmitted data block of length by a CP of length , while using frequency domain equalization at the receiver.

While the first mobile communications standards focused primarily on voice communication, the emphasis now has returned to the provision of systems optimized for data. This trend began with the 3rd Generation Wideband Code Division Multiple Access (WCDMA) system designed in the 3GPP, and is now reaching fulfilment in its successor, known as the ‘Long-Term Evolution’ (LTE). LTE is the first cellular communication system optimized from the outset to support packet-switched data services, within which packetized voice communications are just one part.

LTE is an enabler. It is not technology for technology’s sake, but technology with a purpose, connecting people and information to enable greater things to be achieved. It will provide higher data rates than ever previously achieved in mobile communications, combined with wide-area coverage and seamless support for mobility without regard for the type of data being transmitted.

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The fourth generation (4G) of wireless cellular systems has been a topic under discussion for a long time, probably since the formal definition of third generation (3G) cellular systems was completed by the International Telecommunications Union (ITU) in 1997.

Upon completing the development of the 3G family of standards, the Third Generation Partnership Project (3GPP) started working on Long Term Evolution (LTE) systems during the Release 8 (Rel-8) of the standards. Being the first cellular system based on Orthogonal Frequency Division Multiple Access (OFDMA), it represented a major breakthrough in terms of achieving peak data rates of 300 Mbps in the downlink. However, both LTE Rel-8 and Rel-9 specifications did not meet the IMT-Advanced requirements established by the ITU for 4G systems. LTE-Advanced, the first accepted 4G system whose standardization was initiated in Rel-10 by 3GPP, was born as the resulting efforts of 3GPP to meet those requirements. Major performance goals included peak rates of 1 Gbps in the downlink and 500 Mbps in the uplink. However, current predictions for future systems point out tremendous challenges far beyond what the ITU initially established for 4G. Driven by both the explosion of users’ demands for mobile data along with new services and applications, and the need for a ubiquitous and wirelessly accessible cloud platform, the evolution of future mobile traffic is expected to boom. Applications and services demand ever-increasing data rates. A traffic growth of up to 30 times has been predicted to take place between the years 2010 and 2015. By 2016, more than 10 exabytes of traffic per month will be circulating across cellular networks and more than 4 billion 3GPP wireless subscriptions will be operating in the network. With these forecasts in mind, it becomes critical to provide not only very high broadband capacity, but also efficient support for a variety of traffic types, flexible and cost efficient deployments, energy efficient communications strategies, robust systems against emergencies, and a balance between backward compatibility and future enhancements.

The standardization of LTE became one of the most important technology shifts in cellular networks since the introduction of WCDMA. However, it was not until the introduction of LTE-Advanced in Rel-10 that the requirements established by the ITU for 4G technologies were finally achieved. Nevertheless, both industry and academia have continued improving LTE-Advanced through enhancements in the core technologies of carrier aggregation, MIMO, relaying, and cooperative multipoint communications. In addition, in order to cope with the ever increasing demand for ubiquitous and high-speed data access, the efforts have recently focused on improving the support of heterogeneous networks, as well as device-to device and machine-type communications. In addition to these technologies, the new paradigm of self-organizing networks has the potential of transforming the cellular network into a dynamic entity capable of automatically adjusting itself to guarantee the best possible service by exploiting all the aforementioned technologies. This evolution will continue, not only by improving these technologies, but also by introducing new ones, especially at higher frequency bands capable of satisfying the demand for even faster data access than the ones seen today.

Cognitive radio (CR), which allows secondary users (SUs) to opportunistically utilize the frequency spectrum originally assigned to licensed primary users (PUs), is a promising approach to alleviate spectrum scarcity. In CR networks with single-antenna nodes, SUs can transmit only when it detects a spectrum hole in either time or frequency domain,

so as to avoid causing harmful interference to PUs. Such schemes, however, only work when the primary system severely underutilizes the assigned spectrum. Otherwise, the secondary system would not have adequate chances to access the wireless channel. Recent development in multiple-input multiple-output (MIMO) antenna techniques opens up a new dimension, namely space, for co-channel users to coexist without causing severe interference to each other. Indeed, in CR networks where stations are equipped with multiple antennae, SUs can transmit at the same time as the PUs through space-domain signal processing. The nature of CR networks gives rise to several challenging issues that do not exist in traditional MIMO systems. First, SUs are solely responsible for suppressing the interference they cause to PU receivers, as the primary system should not be aware of the existence of the secondary system. That is, we cannot rely on the PUs to do receiver-side interference cancellation. Secondly, SUs may not have the luxury of knowing the channel state information (CSI) on the links to PUs, as the primary system would not deliberately provide their channel estimation to the secondary system. This imposes difficulty on transmitter-side pre-interference cancellation at SU transmitters. It is therefore necessary to revisit space-domain signal processing in the context of MIMO CR networks. In particular, SUs need to configure their beamforming patterns in a way that balances between their own throughput and the interference they cause to PUs.

Due to the proliferation of various high-bandwidth applications, the most benign, low frequency radio spectrum is becoming over-crowded. A natural option is to use higher carrier frequencies, such as for example millimeter-waves (mm waves) at say 60 GHz, where these high-frequency carriers have a potentially high bandwidth, but are characterized by a low wireless propagation range. Therefore, a large number of Radio Access Points (RAPs) are required for providing seamless coverage. In order to cope with the increasing bandwidth demand per user, network operators often have to split the existing cells into smaller cells. However, increasing the number of base-stations is not always a feasible option due to the higher infrastructure costs involved. One of the major access network solutions for future highbandwidth wireless communication systems is based on optical fibers for the transmission of radio signals between the Base Station (BS) and RAPs, which is generally referred to as a Radio Over Fiber (ROF) solution.