The following problems may be answered in Chinese or English. You need to give all details in order to receive any credit (point).

1. (+20) A ternary communication channel is shown in Fig.1. Assume the input symbols -1, 0 and 1 occur with probability 1/4, 1/2 and 1/4, respectively.

   ![Fig.1](image)

   (a)(+10) Find the probabilities of the output symbols.
   (b)(+10) Assume that a 0 is observed as an output. What is the probability that the input was -1? 0? and 1?

2. (+20) Let $X$ be a binomial random variable that results from the performance of $n$ Bernoulli trials with probability of success $p$.
   (a)(+10) Assume $X=1$. Find the probability that the single event occurred in the $k$-th Bernoulli trial.
   (b)(+10) Assume $X=2$. Find the probability that two events occurred in the $j$-th and the $k$-th Bernoulli trials, where $j<k$.

3. (+20) (a)(+10) Let $X$ and $Y$ be the jointly Gaussian random variables with the probability density function (pdf)

   \[ f_{X,Y}(x,y) = \frac{1}{2\pi\sqrt{1-p^2}} e^{-\frac{1}{2(1-p^2)}[(x-\mu_x)^2+p^2(y-\mu_y)^2]} \quad -\infty < x, y < \infty \]

   Find the marginal pdfs.
   (b)(+10) Let $X$, $Y$, and $Z$ be the jointly Gaussian random variables with the pdf

   \[ f_{X,Y,Z}(x,y,z) = \frac{1}{2\pi\sqrt{3\pi/2}} e^{-\frac{1}{2}(x-\mu_x)^2+\frac{1}{2}(y-\mu_y)^2+\frac{1}{2}(z-\mu_z)^2}} \quad -\infty < x, y, z < \infty \]

   Show that $X$ and $Z$ are independent zero-mean, unit-variance Gaussian random variables.

4. (+15) Let $U$ and $V$ are independent zero-mean, unit-variance Gaussian random variables. Additionally, we have $X = U + V$ and $Y = 2U + V$.
   (a)(+10) Find the joint characteristic function of $X$ and $Y$.
   (b)(+5) Find $E[XY]$.

5. (+10) Let $X$ and $Y$ be zero-mean, unit-variance independent Gaussian random variables. Find the value of $r$ for which the probability that the coordinate $(X, Y)$ falls inside a circle of radius $r$ is 1/3.

6. (+15) Find the joint pdf of $(U, V, W)$, where we have

   \[ U = X_1, \quad V = X_1 + 2X_2 \quad \text{and} \quad W = X_1 + 2X_2 + X_3. \]

   The $X_i$ for $i = 1, 2, 3,$ are independent zero-mean, unit-variance Gaussian random variables.
1. (20 points) The lowpass signal $x(t)$ with a bandwidth of $W$ is sampled at the Nyquist rate and the signal
\[ x_k(t) = \sum_{n=-\infty}^{\infty} (-1)^n x(nT_s)\delta(t - nT_s) \]
is generated.
A. Find the Fourier transform of $x_k(t)$.
B. Can $x(t)$ be reconstructed from $x_k(t)$ by using an LTI system? Why?

2. (20 points) An AM signal is generated by modulating the carrier $f_c = 800$ kHz by the signal $m(t)=\sin 2000\pi t + 5\cos 4000\pi t$.
The AM signal $s(t)=100(1+m(t))\cos 2\pi f_c t$ is fed to a 50 $\Omega$ load.
A. Determine and sketch the spectrum of the AM signal.
B. Determine the average power in the carrier and in the sideband.
C. What is the modulation index?
D. What is the peak power delivered to the load?

3. (20 points) For each of the following processes, find the power-spectral density.
A. $X(t) = A\cos(2\pi ft + \Theta)$, where $A$ is a constant and $\Theta$ is a random variable uniformly distributed on $[0, \pi/4]$.
B. $X(t) = X + Y$, where $X$ and $Y$ are independent, $X$ is uniform on $[-1, 1]$ and $Y$ is uniform on $[0, 1]$.

4. (20 points) The received signal $r(t) = s(t) + n(t)$ in a communication system is passed through an ideal LPF with bandwidth $W$ and unity gain. The signal component $s(t)$ has a power-spectral density
\[ S_s(f) = \frac{P_s}{1 + (f/B)^2} \]
where $B$ is the 3-dB bandwidth. The noise component $n(t)$ has a power-spectral density $N_0/2$ for all frequencies. Determine and plot the SNR as a function of the ratio $W/B$. What is the filter bandwidth $W$ that yields a maximum SNR?

5. (20 points) Suppose you have a set of $M$ signal waveform $x_m(t)$, $1 \leq m \leq M$ which are to be used for transmitting information over a communication channel. From the set of $M$ waveforms, you would like to construct a set of $N \leq M$ orthonormal waveforms, where $N$ is the dimension of the signal space. What should you do? Please describe your approach in details.

試題隨卷繳交
I. Vocabulary (20%): Choose the most appropriate word to complete the following sentences.

1. The biggest ________ to peace in the Middle East may be the acts of terrorism.
   (a) accidence  (b) decadence  (c) assistance  (d) hindrance

2. Our school’s ________ administration decided to save money by dimming all the lights. The students could barely see to read.
   (a) frivolous  (b) querulous  (c) parsimonious  (d) surreptitious

3. This professor’s lectures are noted for their ________. He frequently finishes speaking before even half the hour is up.
   (a) identity  (b) brevity  (c) vilify  (d) duplicity

4. Dropping out of school is seldom a ________ decision, but many young people drop out anyway.
   (a) judicious  (b) discerning  (c) whimsical  (d) virtuous

5. The ________ of the luxurious resort was in stark contrast to the poverty of the little fishing village at its gates.
   (a) opulence  (b) permanence  (c) proximity  (d) affinity

6. Although my grandfather is still in pretty good health, old age is taking its toll on him, ________.
   (a) irascible  (b) immutable  (c) inexorable  (d) inscrutable

7. The grief one feels over the loss of a loved one never fully goes away, but time does ________ the pain.
   (a) incite  (b) garner  (c) assuage  (d) languish

8. Knowing a lot does not necessarily make people effective communicators. They need to be ________ in order to reach others with their words.
   (a) laconic  (b) garrulous  (c) satirical  (d) articulate

9. Scientists are not sure whether alcoholism is a ________ tendency existing from birth or a learned pattern of behavior.
   (a) elusive  (b) congenial  (c) precocious  (d) virulent

10. If you are naturally ________, don’t become a TV sportscaster. Sports announcers are expected to talk nonstop.
    (a) taciturn  (b) deficient  (c) officious  (d) cordial

II. Cloze (20%): Choose the most appropriate expression for each of the blanks from the four options given.

In theory, the global Internet is highly resistant to catastrophic failure. _____(11)_____ its a mesh of interconnected smaller networks, all providing alternative data pathways. _____(12)_____ any single link fail. _____(13)_____, Asia’s abundant data capacity and plentiful circuits ensured that most traffic was quickly rerouted after the earthquake. _____(14)_____, crucial services such as phone connections. Some of the overflow was also handled by satellite systems. _____(15)_____ are normally too costly and lack the bandwidth of terrestrial networks.  

11. (a) although  (b) because  (c) unless  (d) while

12. (a) should  (b) would  (c) must  (d) may

13. (a) However  (b) But  (c) Indeed  (d) Namely

14. (a) restore  (b) restoring  (c) restored  (d) to restore

15. (a) that  (b) which  (c) where  (d) whether

Even _____(16)_____, their current torrid rates of growth, it will take decades before nations like China and India are rich enough to decide they want to combat pollution — and by then the damage may be irreversible. The good news is that today’s Asians may not have to wait that long. Contemporary antipollution and energy-efficiency technology is _____(17)_____, that used in the West’s first cleanups. If developing Asia commits soon to investing in _____(18)_____, policies and technology, the region could take a green leap forward. _____(19)_____, that will require serious investment from those developing advanced technologies in the rich world, but the scale of Asia’s environmental challenges is _____(20)_____, everyone has a stake in its success.
III. Reading Comprehension (40%): Choose the correct answer according to the given passages

Reading 1: 3 Questions

The girls in this sixth grade class in East Palo Alto, California, all have the same access to computers as boys. But researchers say, by the time they get to high school, they are victims of what the researchers call a major new gender gap in technology.

Janice Weinman of the American Association of University Woman says, “Girls tend to be less comfortable than boys with the computer. They use it more for word processing rather than for problem solving, rather than to discover new ways in which to understand information.”

After re-examining a thousand studies, the American Association of University women researchers found that girls make up only a small percentage of students in computer science classes. Girls consistently rate themselves significantly lower than boys in their ability and confidence in using computers. And they use computers less often than boys outside the classroom.

The instructor of this computer lab says he’s already noticed some differences. Charles Cheadle of Cesar Chavez School says, “Boys are not so afraid they might do something that will harm the computer, whereas girls are afraid they might break it somehow.”

Six years ago, the software company Purple Moon noticed that girls’ computer usage was falling behind boys. Karen Gould says, “The number one reason girls told us they don’t like computer games is not because they’re too violent, or too competitive. Girls just said they’re incredibly boring.”

Purple Moon says it found what girls want, characters they can relate to and story lines relative to what’s going on in their own lives. Karen Gould of Purple Moon Software says, “What we definitely found from girls is there is no intrinsic reason why they wouldn’t want to play on a computer; it was just a content thing.”

The sponsor of the study says it all boils down to this, the technology gender gap that separates the girls from the boys must be closed if women are to compete effectively with men in the 21st century.

21. In this sixth grade classroom, you would find _____.
(a) only boys allowed to use the computers
(b) only girls allowed to use the computers
(c) no computers in the classroom
(d) both boys and girls allowed to use the computers

22. Girls usually rate themselves _____.
(a) as being uncomfortable using computers
(b) as comfortable using computers
(c) as experts with computers
(d) as very good with using computers
23. Girls seem to find most of the software _____.
(a) as too violent
(b) boring
(c) as too competitive
(d) exciting

Reading 2: 8 Questions

Every second, 1 hectare of the world's rainforest is destroyed. That's equivalent to two football fields. An area the size of New York City is lost every day. In a year, that adds up to 31 million hectares -- more than the land area of Poland. This alarming rate of destruction has serious consequences for the environment; scientists estimate, for example, that 137 species of plant, insect or animal become extinct every day due to logging. In British Columbia, where, since 1990, thirteen rainforest valleys have been cleared, 142 species of salmon have already become extinct, and the habitats of grizzly bears, wolves and many other creatures are threatened. Logging, however, provides jobs, profits, taxes for the government and cheap products of all kinds for consumers, so the government is reluctant to restrict or control it.

Much of Canada's forestry production goes towards making pulp and paper. According to the Canadian Pulp and Paper Association, Canada supplies 34% of the world's wood pulp and 49% of its newsprint paper. If these paper products could be produced in some other way, Canadian forests could be preserved. Recently, a possible alternative way of producing paper has been suggested by agriculturalists and environmentalists: a plant called hemp.

Hemp has been cultivated by many cultures for thousands of years. It produces fiber which can be made into paper, fuel, oils, textiles, food, and rope. For many centuries, it was essential to the economies of many countries because it was used to make the ropes and cables used on sailing ships; colonial expansion and the establishment of a world-wide trading network would not have been possible without hemp. Nowadays, ships' cables are usually made from wire or synthetic fibers, but scientists are now suggesting that the cultivation of hemp should be revived for the production of paper and pulp. According to its proponents, four times as much paper can be produced from land using hemp rather than trees, and many environmentalists believe that the large-scale cultivation of hemp could reduce the pressure on Canada's forests.

However, there is a problem: hemp is illegal in many countries of the world. This plant, so useful for fiber, rope, oil, fuel and textiles, is a species of cannabis, related to the plant from which marijuana is produced. In the late 1930s, a movement to ban the drug marijuana began to gather force, resulting in the eventual banning of the cultivation not only of the plant used to produce the drug, but also of the commercial fiber-producing hemp plant. Although both George Washington and Thomas Jefferson grew hemp in large quantities on their own land, any American growing the plant today would soon find himself in prison -- despite the fact that marijuana cannot be produced from the hemp plant, since it contains almost no THC (the active ingredient in the drug).

In recent years, two major movements for legalization have been gathering strength. One group of activists believes that ALL cannabis should be legal -- both the hemp plant and the marijuana plant -- and that the use of the drug marijuana should not be an offense. They argue that marijuana is not dangerous or addictive, and that it is used by large numbers of people who are not criminals but productive members of society. They also point out that marijuana is less toxic than alcohol or tobacco. The other legalization movement is concerned only with the hemp plant used to produce fiber; this group wants to make it legal to cultivate the plant and sell the fiber for paper and pulp production. This second group has had a major triumph recently: in 1997, Canada legalized the farming of hemp for fiber. For the first time since 1938, hundreds of farmers are planting this crop, and soon we can expect to see pulp and paper produced from this new source.
24. How long does it take for 100 hectares of rainforest to be destroyed?
   (a) less than two minutes
   (b) about an hour
   (c) two hours
   (d) a day

25. Why is pulp and paper production important to Canada?
   (a) Canada needs to find a way to use all its spare wood.
   (b) Canada publishes a lot of newspapers and books.
   (c) Pulp and paper import is a major source of income for Canada.
   (d) Pulp and paper export is a major source of income for Canada.

26. Who is suggesting that pulp and paper could be produced without cutting down trees?
   (a) the government
   (b) the logging industry
   (c) the charity
   (d) the environmental lobby

27. Why was the plant hemp essential to world-wide trade in the past?
   (a) Ships' ropes were made from it.
   (b) Hemp was a very profitable export.
   (c) Hemp was used as fuel for ships.
   (d) Hemp was used as food for sailors.

28. Why do agriculturalists think that hemp would be better for paper production than trees?
   (a) It is cheaper to grow hemp than to cut down trees.
   (b) More paper can be produced from the same area of land.
   (c) Hemp produces higher quality paper.
   (d) Hemp is more economical.

29. When was hemp production banned in Canada?
   (a) 1930
   (b) 1960
   (c) 1996
   (d) 1938

30. Why was hemp banned?
   (a) It is related to the marijuana plant.
   (b) It can be used to produce marijuana.
   (c) It was no longer a useful crop.
   (d) It was destructive to the land.
College graduation brings both the satisfaction of academic achievement and the expectation of a well-paying job. But for 6000 graduates at San Jose State this year, there’s uncertainty as they enter one of the worst job markets in decades. Ryan Stewart has a freshly minted degree in religious studies, but no job prospects. “You look at everybody’s parents and neighbors, and they’re getting laid off and don’t have jobs,” said Stewart. “Then you look at the young people just coming into the workforce... it’s just scary.” When the class of 2003 entered college the future never looked brighter. But in the four years they’ve been here, the world outside has changed dramatically.

“Those were the exciting times, lots of dot-com opportunities, exploding offers, students getting top dollar with lots of benefits,” said Cheryl Allmen-Vinnidge, of the San Jose State Career Center. “Times have changed. It’s a new market.”

Cheryl Allmen-Vinnidge ought to know. She runs the San Jose State Career Center (it is) sort of a crossroads between college and the real world. Allmen-Vinnidge says students who do find jobs after college have done their homework.

The typical graduate who does have a job offer started working on it two years ago. They’ve postured themselves well during the summer. They’ve had several internships,” she said.

And they’ve majored in one of the few fields that are still hot – like chemical engineering, accounting, or nursing – where average starting salaries have actually increased over last year. Other popular fields (like information systems management, computer science, and political science) have seen big declines in starting salaries.

Ryan Stewart (he had hoped to become a teacher) may just end up going back to school. “I’d like to teach college some day and that requires more schooling, which would be great in a bad economy,” he said.

To some students a degree may not be ticket to instant wealth. For now, they can only hope its value will increase over time.

32. This story mentions college graduates at ________
   (a) San Jose State Career Center.
   (b) San Jose Community College.
   (c) San Jose State University.
   (d) San Jose Polytechnic High School.

33. The main idea of this story is that ________
   (a) Ryan Stewart has not been able to find a job.
   (b) a college career center is a crossroads between college and the real world.
   (c) in some fields, salaries have increased in the past year.
   (d) between 1999 and 2003, the job market changed dramatically.
34. Ryan Stewart _________.
   (a) is a teacher.
   (b) found a job as soon as he graduated.
   (c) majored in religious studies.
   (d) is going back to school.

35. Which of the following things did not happen in the four years that the class of 2003 was in college?
   (a) Dot com opportunities decreased.
   (b) The number of teaching jobs increased.
   (c) Salaries in chemical engineering increased.
   (d) The number of jobs with benefits decreased.

36. Which of the following majors has the best job prospects, according to the story?
   (a) information systems management
   (b) accounting
   (c) computer science
   (d) teaching

Reading 4: 4 Questions

Before the grass has thickened on the roadside verges and leaves have started growing on the trees is a perfect time to look around and see just how dirty Britain has become. The pavements are stained with chewing gum that has been spat out and the gutters are full of discarded fast food cartons. Years ago I remember travelling abroad and being saddened by the plastic bags, discarded bottles and soiled nappies at the edge of every road. Nowadays, Britain seems to look at least as bad. What has gone wrong?

The problem is that the rubbish created by our increasingly mobile lives lasts a lot longer than before. If it is not cleared up and properly thrown away, it stays in the undergrowth for years; a semi-permanent reminder of what a tatty little country we have now.

Firstly, it is estimated that 10 billion plastic bags have been given to shoppers. These will take anything from 100 to 1,000 years to rot. However, it is not as if there is no solution to this. A few years ago, the Irish government introduced a tax on non-recyclable carrier bags and in three months reduced their use by 90%. When he was a minister, Michael Meacher attempted to introduce a similar arrangement in Britain. The plastics industry protested, of course. However, they need not have bothered; the idea was killed before it could draw breath, leaving supermarkets free to give away plastic bags.

What is clearly necessary right now is some sort of combined initiative, both individual and collective, before it is too late. The alternative is to continue sliding downhill until we have a country that looks like a vast municipal rubbish tip. We may well be at the tipping point. Yet we know that people respond to their environment. If things around them are clean and tidy, people behave cleanly and tidily. If they are surrounded by squalor, they behave squalidly. Now, much of Britain looks pretty squalid. What will it look like in five years?

37. The writer says that it is a good time to see Britain before the trees have leaves because _________.
   (a) Britain looks perfect.
   (b) you can see Britain at its dirtiest.
   (c) you can see how dirty Britain is now.
   (d) the grass has thickened on the verges.

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38. For the writer, the problem is that _____.
   (a) rubbish is not cleared up.
   (b) rubbish last longer than it used to.
   (c) our society is increasingly mobile.
   (d) Britain is a tatty country.

39. Michael Meacher _____.
   (a) followed the Irish example with a tax on plastic bags.
   (b) tried to follow the Irish example with a tax on plastic bags.
   (c) made no attempt to follow the Irish example with a tax on plastic bags.
   (d) had problems with the plastics industry who weren't bothered about the tax.

40. The writer thinks that _____.
   (a) people are squalid.
   (b) people behave according to what they see around them.
   (c) people are clean and tidy.
   (d) people are like a vast municipal rubbish tip.

IV. Composition (20%): Based on the topic below, write within 300 words of a well-structured composition in English

Topic: Life in the Digital Age