**ENSC 100 Quiz: October 12, 2012**

This is a closed-book quiz. Calculators may be used. There is exactly one right answer to each question, which you should indicate on the accompanying bubble sheet. No marks will be deducted for wrong answers. Remember to enter your name and student number on the bubblesheet.

**Section I: In this section, you need to get at least 16 questions right to get full marks (16).**

1. Jacquard developed a loom in which a description of the pattern to be woven into the cloth was stored in the form of:
   * 1. *Punched cards*
     2. Grooves in a wax cylinder
     3. Patterns of magnetization on an iron wire
     4. Notches filed in brass discs
2. According to historian Lewis Mumford, humanity spent its first tens of thousands of years:
   * 1. *Developing language and culture*
     2. Weaving mats and making clay pots
     3. Building great cities which are now lost
     4. In almost-continual inter-tribal warfare
3. In mass production, the cost of an item is determined primarily by:
   * 1. *The cost of the materials used to make it*
     2. The cost of the engineering work needed to design it
     3. The cost of building the construction line
     4. The cost of advertising
4. The *Navier-Stokes* equations describe:
   * 1. *Fluid flow*
     2. Electronic bonding in molecules
     3. Stresses in solid materials
     4. The curvature of space in the vicinity of massive objects
5. Mustard gas and phosgene are examples of:
   * 1. Dyeing agents used to colour thread for weaving
     2. *Chemical weapons used in World War I*
     3. Rocket propellants used for the V2 and the American space program
     4. Chemical fertilizers that have increased crop yields in the Green Revolution
6. According to Sigmund Freud, the theory of psychoanalysis:
   * 1. *Was one of three great scientific revolutions that dealt blows to human vanity*
     2. Is not a science, since its predictions can never be falsified
     3. Is inferior to chemotherapy as a treatment for mental illness
     4. Is not a science, since its predictions can never be verified.
7. Non-dimensional numbers in engineering are useful because:
   * 1. They allow us to draw conclusions about a physical system from a model of that system
     2. They reduce the number of experiments needed to investigate the behavior of a system
     3. They make it easy to communicate with engineers who use a different system of units
     4. *All of the above*
8. *Chernoff faces* are:
   * 1. A form of facial disfigurement found among Chernobyl survivors
     2. *A way of presenting large amounts of graphical information in a way that takes advantage of the brain’s ability to recognize faces*
     3. Stylized faces used by security computers to aid facial recognition
     4. The faces of a twenty-side die used in probability studies
9. If we compare Morse’s *telegraph* with Bell’s *telephone*:
   * 1. Both are analogue forms of communication
     2. Both are digital forms of communication
     3. The first is analogue, the second is digital
     4. *The first is digital, the second is analogue*
10. In the late eighteenth century, the Catalan polymath Don Francisco Salva i Campillo developed a means of communication that depended on:
    * 1. *Giving electric shocks to trained servants*
      2. Reflecting the sun’s rays from a mirror
      3. Allowing water to run out of a cylinder fitted with a piston bearing a series of possible messages
      4. Using an electromagnet to close a switch in a second electrical circuit
11. Henry Hollerith adapted the punched card to store information about:
    * 1. Complex weaving patterns
      2. *the 1890 US population*
      3. the control of lathes for making gun barrels
      4. military codes used by Germany during World War II
12. For the first years of successful operation of the trans-Atlantic telegraph, engineers used the following method:
    * 1. Relay switches at regular intervals along the cable
      2. Using extremely high voltages
      3. *Using exceptionally sensitive galvanometers*
      4. Sending the same message along two parallel cables
13. One of the first researchers to challenge the authority of Aristotle was:
    * 1. Parmenides (Fifth Century BC)
      2. *Abū al-Rayhān Muhammad ibn Ahmad al-Bīrūnī (973-1048)*
      3. St Thomas Aquinas (1225-1274)
      4. Francis Bacon (1561-1626)
14. Each of these four methods of sending secret messages was at one time thought to be absolutely unbreakable, but only one of them actually is. Which one?
    * 1. Caesar’s cipher
      2. The Vignere cipher
      3. *The one-time pad*
      4. Public-key encryption
15. *Albinin* is a liquid that, when painted on the body, suppresses the tanning of the skin by sunlight. A messenger has a one-word message painted on his chest using albinin, then kept in a dark cell until his skin is uniformly pale. He is sent across enemy territory to the leaders of an allied nation. On arrival he is invited to sit in the sunlight, and the message slowly becomes visible. This is an example of:
    * 1. *steganography*
      2. cryptography
      3. cryptogamy
      4. stethoscopy
16. The statement `Energy can neither be created or destroyed’ is one version of:
    * 1. The Zeroth Law of Thermodynamics
      2. *The First Law of Thermodynamics*
      3. The Second Law of Thermodynamics
      4. The Third Law of Thermodynamics
17. One of the key inventions that made long-range electrical telegraphy possible in the nineteenth century was:
    * 1. the cavity magnetron
      2. the dynamo
      3. the direct-current electric motor
      4. *the electrical relay switch*
18. The creation of the field of Information Science is generally credited to:
    * 1. Alan Turing
      2. *Claude Shannon*
      3. Norbert Wiener
      4. John von Neumann
19. What method did the Chappe semaphore use to communicate information over long distancesin nineteenth-century France?
    * 1. Reflected sunlight
      2. Electric shocks to trained servants
      3. Timed volleys of gunfire
      4. *The movement of large mechanical arms mounted on top of towers*
20. Friedrich Wilhelm Kasiski published a solution to the Vignere cipher in 1863. Before this, an example of the cipher had already been cracked by *this* English inventor:
    * 1. Roger Bacon
      2. Francis Bacon
      3. William Stanley Jevons
      4. *Charles Babbage*
21. About how far can a sample of human speech be compressed before it becomes incomprehensible?
    * 1. It can be shortened by about 10%
      2. Its length can be cut in half
      3. Its length can be reduced by 75%
      4. *It can be shortened by more than 90%.*
22. The nineteenth-century engineer Osborne Reynolds distinguished two types of fluid flow, one of which typically prevails at low velocities, the other at higher velocities. These two types of flow are called, respectively:
    * 1. Confluent and divergent
      2. Passive and active
      3. Linear and non-linear
      4. *Laminar and turbulent*
23. According to the `trickle-down theory’, when did scientists first overtake engineers as heroes of the popular imagination?
    * 1. The mid-fourteenth century
      2. The early seventeenth century
      3. The late nineteenth century
      4. *The mid-twentieth century*
24. To ensure that the behaviour of a one-metre-high model house placed in a wind-tunnel resembles that of a similar, ten-metre-high building in a hurricane:
    * 1. *We must ensure that the Froude number is the same in both cases*
      2. The wind-tunnel must be able to reproduce the wind speed of the hurricane
      3. We must ensure that the Reynolds number is the same in both cases
      4. The wind speed in the wind tunnel must be exactly one-tenth of the hurricane’s wind speed

**Section II: In this section you need to get all questions right in order to get full marks (16).**

1. What is the information content of a picture on a megapixel

computer screen, if each pixel can have any one of 256 colours?

* + 1. 106 bits
    2. 256 🗙 106
    3. *8 🗙 106*
    4. 28 🗙 1,000,000

1. If you XOR the string (100110101) with (010101101), the result is:
   * 1. (110100110)
     2. *(110011000)*
     3. (001100111)
     4. (001011001)
2. A Morse code message consists of a series of 200-millisecond intervals, each of which can take one of three values: a dot, a dash, or silence. I listen to one second of this message. What is the maximum possible information content of what I’ve heard?
   * 1. 5 bits
     2. *Just less than 8 bits*
     3. 15 bits
     4. 243 bits
3. We drop a fully-charged battery into a bucket of cold salt water. The water shorts out the battery and it discharges, warming up the water. If we consider the system consisting of water plus battery, what change has occurred to the system?
   * 1. Its energy has increased and its entropy has gone down
     2. *Its energy has stayed the same and the entropy has gone up*
     3. Its energy has gone up and the entropy has stayed the same
     4. Its energy has stayed the same and the entropy has gone down
4. An inventor claims to have developed a device which, drawing 1 kW of electrical power, will deliver 3 kW of heat to a living room. Such a device:
   * 1. *Is perfectly possible*
     2. Violates the First Law of Thermodynamics
     3. Violates the Second Law of Thermodynamics
     4. Both (b) and (c).
5. The *Carnot efficiency* is:
   * 1. An upper bound of the efficiency of all machines
     2. The efficiency that every heat engine must necessarily have
     3. *An upper bound on the efficiency of any heat engine*
     4. A lower bound on the efficiency of any heat engine
6. An inventor has designed a device in which water from a reservoir is drawn up a large number of fine tubes by capillary action. The water is supposed to emerge from the top of the tubes into a second reservoir. At intervals, water from this second reservoir is released into a much wider tube, where it flows back down to the first reservoir, turning a turbine to produce electricity. Such a device would be:
   * 1. *A perpetual motion machine of the first kind*
     2. A perpetual motion machine of the second kind
     3. A perpetual motion machine of the third kind
     4. A practical means of generating electricity
7. A heat pump is a device that:
   * 1. Uses the difference in temperature between two objects to move a fluid
     2. Uses mechanical power to move heat from a hot object to a cold object
     3. *Uses mechanical power to move heat from a cold object to a hot object*
     4. Extracts work from hot fluids
8. Imagine we have an empty cardboard box, well insulated, so that no heat or electric current can pass through the walls. Which of the following scenarios necessarily violates the First Law of Thermodynamics (also known as the Law of Conservation of Energy)?
   * 1. A bucket of lukewarm water is placed in the box. When the box is opened, a cloud of steam escapes, and there is some ice left in the bottom of the bucket.
     2. *A bucket of lukewarm water is placed in the box. When the box is opened, the bucket is found to be full of ice.*
     3. A bucket of boiling water is placed in the box and a lump of ice added. When the box is opened, the bucket is found to be full of luke-warm water.
     4. A bucket of boiling water and a discharged battery are placed in the box. When the box is opened, the water is cold and the battery is fully charged.
9. Imagine we have an empty cardboard box, well insulated, so that no heat or electric current can pass through the walls. Which of the following scenarios does not necessarily violate the Second Law of Thermodynamics?
   * 1. A bucket of lukewarm water is placed in the box. When the box is opened, a cloud of steam escapes, and there is some ice left in the bottom of the bucket.
     2. A bucket of lukewarm water is placed in the box. When the box is opened, the bucket is found to be full of ice.
     3. *A bucket of boiling water is placed in the box and a lump of ice added. When the box is opened, the bucket is found to be full of luke-warm water.*
     4. A bucket of boiling water and a discharged battery are placed in the box. When the box is opened, the water is cold and the battery is fully charged.
10. If I ask you to guess a *mystery letter*, and the only thing you know is that it will be one of the 26 lower-case letters in the English alphabet, the amount of information you are missing is:
    * 1. 26 bits
      2. 226 bits
      3. *About 4.7 bits*
      4. 1026 bits
11. A primitive form of the Chappe semaphore consists of a single wooden arm on top of a tower. This arm can take one of five positions: `Full Down’, `Half Down’, `Level’, `Half Up’ and `Full Up’. An observer watches the semaphore through a telescope and notes down three consecutive positions of the arm. What is the maximum possible information content of what he’s recorded?
    * 1. 5 bits
      2. *Slightly less than 7 bits*
      3. 15 bits
      4. 125 bits
12. I have two strings of random binary digits (`bits’). Each of these strings is *N* bits long and the information content of each string is therefore *N*. If I now XOR the strings together, bit by bit, the result will be a single string of length *N*. The information content of this string is:
    * 1. N/2
      2. *N*
      3. 2N
      4. 2N
13. *Hexadecimal* is a sixteens-based notation for writing numbers. In hexadecimal, the integers 0 to 9 have their conventional meanings, and the numbers 10, 11, 12, 13, 14 and 15 are represented by the letters A to F. What is the information content of a string of eight hexadecimal digits, such as F11A23B3?
    * 1. 8
      2. *32*
      3. 128
      4. 168
14. An electrically powered heat pump absorbs heat from a heat source at 300 K (room temperature in a warm room), and transfers it to an oven at 600 K. If the heat pump is operating at the maximum thermodynamically possible efficiency, how much electrical power must it consume in order to supply 1 kW of heat to the oven ?
    * 1. *0.5 kW*
      2. 1 kW
      3. 2 kW
      4. 9 kW
15. The first law of thermodynamics says that:
    * 1. *The energy of an isolated system must be constant*
      2. The entropy of an isolated system must be constant
      3. The temperature of an isolated system must be constant
      4. The energy of an isolated system can only decrease