Final Exam, ENSC 100, 1200-1500, Dec 12, 2004

Name:

Group:

Student Number:

This is a closed-book exam. You may not consult any written material of any kind during the examination.

All questions are multiple choice and are worth three points. There is exactly one correct answer to each question. One point will be deducted for each incorrect answer. You may circle as many answers as you like to each question.

Mark your answers directly on the exam sheet.

1. According to the first few lectures in the course, which of the following is *not* a possible explanation for the slow pace of engineering progress over the period 35,000 BC to 10,000 BC?

   a) Engineers at that period had small brains
   b) Experimenting with new methods was excessively risky
   c) Humanity was busy developing language and culture
   d) Human groups were small and isolated

2. Archimedes was employed in the city of

   a) Rome
   b) Athens
   c) Boston
   d) Syracuse

3. The word 'engineer' originates from:

   a) A Greek word meaning 'worker'
   b) A Latin word meaning 'siege engine'
   c) A Sanskrit word meaning 'artisan'
   d) A German word meaning 'canal-digger'

4. When the operation of weaving was first mechanised, the weavers began to work in large buildings called 'mills' rather than in their own cottages. This was because:

   a) they wanted to work together so they could unionise effectively
   b) it was more economical to light and heat large buildings
   c) it was impossible to make efficient cottage-scale steam engines
   d) working together made it easy to share knowledge, and hence to progress

5. Between 1880 and 1930, the number of engineers in North America:

   a) Stayed roughly the same
   b) Doubled
   c) Increased tenfold
   d) Increased a hundredfold

6. *Teledeltos paper* is an electrically-conducting form of paper. Engineers used to cut shapes from this paper, attach appropriate current and voltage sources to it, and, by measuring the electrical potential at various points on the paper, draw conclusions about the temperature that would be measured at the corresponding points in a thermal system. In doing this, they were using the paper as:

   a) a primitive neural net computer
   b) a primitive digital computer
   c) an analog computer
   d) a finite-element computer

7. When applying the results of a wind-tunnel test in a scale model to predicting the performance of a real plane, we need to enforce *dynamic similarity* between the model and the plane. This means that:

   a) if the length of the model is one-tenth that of the plane, the volume of the model must be one-thousandth that of the plane
   b) the wind speed in the wind tunnel must equal the wind speeds that the real plane will experience
   c) the ratio of the model's dimensions to those of the plane must stay the same over time
   d) the important forces experienced by the model must be in the same ratio to each other as the corresponding forces experienced by the plane

8. Imagine a collection of gas molecules inside a closed container. Each molecule has a different speed and direction of motion. Now imagine that we have a magical device that lines up the directions of motion of each molecule, so that each molecule retains its original speed, but is now moving due North. As a result of this change, the gas inside the container:

   a) has increased in energy and in entropy
   b) has the same energy but higher entropy
   c) has the same energy but lower entropy
   d) has the same energy and entropy

9. According to the 'thermodynamics' lecture, one important factor often omitted in comparing the efficiencies of electric and gas-powered vehicles for the Canadian market is:

   a) electric motors are more efficient than gas motors
   b) gas motors become more efficient in cold weather
   c) gas-powered vehicles provide heat to keep the passengers warm
   d) gas-powered vehicles rely on a non-renewable resource

10. A sadistic engineering professor has set a multiple-choice exam with 50 multiple-choice questions, in which each question has 64 possible answers. What is the minimum number of bits of information you would need in order to be sure of scoring full marks in such an exam?

    a) 3,200 bits
    b) 300 bits
    c) $\log_2(3{,}200)$ bits
    d) 50×2^{64} bits

11. Engineering economics is based on the idea that we would rather have $100 today than $100 in a year's time. Our preference is expressed as an 'interest rate'; for example, if we can invest money at 10% annual interest, then we should be prepared to loan $100 today if we expect to be paid back at least:

    a) $110 in 2 years time
    b) $120 in 2 years time
    c) $121 in 2 years time
    d) None of the above

12. Using the same reasoning as in the previous question, what is the most we should invest today in preventing a leak from a repository of radioactive waste 200 years from now, given that the leak will do a billion dollars worth of damage?

    a) A billion dollars
    b) A million dollars
    c) About 5 dollars
    d) Less than a cent

13. The philosopher John Searle has advanced an argument known as the 'Chinese Room Argument', in which he invites us to imagine a non-Chinese-speaking man inside a room, following a set of written rules to generate answers (in Chinese) to questions, written in Chinese, that are passed through a slit into the room. The purpose of this argument is to convince us that:

    a) Behaviour is not sufficient to prove intelligence
    b) A man can do things which no computer can do
    c) True intelligence must be demonstrated by actions, not words
    d) Intelligent behaviour can be generated by following a set of formal rules.

14. The purpose of the Turing test proposed by Alan Turing is:

    a) To provide a practical test that will replace endless debates about the meaning of the word 'intelligence'
    b) To provide a clearcut way of distinguishing human intelligence from computer intelligence
    c) To demonstrate that human and computer intelligence are two forms of the same thing
    d) To demonstrate how easily humans can be fooled into attributing intelligence to a computer

15. Which of the following statements is consistent with Dr John Bird's views on artificial intelligence, as presented in lectures:

    a) Computers are 'agents governed by necessity', but humans are not.
    b) Computers are 'agents governed by necessity', and humans may or may not be.
    c) We can never know whether any given agent is governed by necessity or not.
    d) Only agents governed by necessity can be truly intelligent

16. Which of the following further statements is consistent with Dr Bird's views on AI:

    a) Intelligence lies on a continuum, gradually increasing as one goes from bacteria to human beings
    b) Intelligence may emerge from unintelligent agents if they are connected together to form a sufficiently complex system
    c) Even an AND gate displays a rudimentary level of intelligence
    d) The ability to make free choices is essential for true intelligence

17. Dow's chemists found that one benefit of adding polystyrene to napalm is that:

    a) It makes it burn underwater
    b) It makes it poisonous
    c) It makes it sticky
    d) It raises the combustion temperature

18. In *The Ultimate Resource*, Harvard economist Julian Simon argues that:

    a) We will run out of many renewable resources within the next 25 years
    b) Many millions will die of mass starvation in the next decade
    c) We can tell when we're running short of a resource because its price will rise
    d) Our present way of life is unsustainable, because our 'ecological footprint' is larger than the planet.

19. In rebutting Dr Jones's environmental lecture, Josha McNab introduced Kuznet's Curve. This curve is intended to show that:

    a) Pollution increases in proportion to Gross National Product
    b) Pollution increases with average income up to a certain level, but then starts to decline again
    c) The most polluting societies are the very poorest and the very richest
    d) To reduce pollution, we must reduce our reliance on technology

20. We have a well-insulated box, separated into two sections by an insulating partition. On one side of the partition is boiling water, on the other side is ice. We remove the partition and allow the contents of the box to come to equilibrium, at which point the box contains warm water. As a result of having removed the partition:

    a) the energy of the box contents stays the same, but the entropy falls
    b) the energy of the box contents stays the same, but the entropy increases
    c) both the energy and entropy of the box contents stay the same
    d) none of the above

21. The 'solve' function on electronic calculators can find solutions for a range of non-linear equations. One algorithm that can be used for this purpose is:

    a) the back-propagation algorithm
    b) the method of steepest descent
    c) the secant method
    d) the quadratic formula

22. We have two sequences of a million digits. One sequence was generated by a random process, such as measuring the seconds between successive decays of uranium nuclei. The other was generated by a chaotic process, such as the application of the iterative equation

$$x_n = (1 + r)x_{n-1} - rx_{n-1}^2$$

to an initial 'seed' value x_0. If we compare the information content of the two sequences, we find that:

a) both have the same information content
b) the chaotic sequence has a higher information content than the random sequence
c) the random sequence has a higher information content than the chaotic sequence
d) it is not possible to make a meaningful comparison of the information contents of the two sequences.

23. One characteristic of chaotic processes, such as the generation of successive values of x_n described in Question 22, is that:

a) The value of x_n always tends to a fixed limit as n increases
b) For a given n, x_n may change drastically for small changes in x_0.
c) The value of x_n cannot be predicted, even if the values from x_0 to x_{n-1} are known exactly.
d) For n greater than a certain threshold value, successive terms in the sequence go through a repetitive cycle whose length is a power of 2.

24. According to lectures, the earliest use of electricity as a method of torture was by:

a) the Gestapo in occupied Europe
b) the KGB in the USSR under Stalin
c) the French in Algeria
d) the US in Vietnam

25. Referring to Question 24, the earliest instruments used for electrical torture were:

a) electro-shock batons
b) hand-cranked field telephones
c) Leyden jars
d) tasers

26. You are in a car travelling at 10 km/h. A balloon filled with hydrogen is floating in the middle of the car. All the car windows are closed. You suddenly step on the accelerator, causing the car to accelerate to 30 km/h in the space of 2 seconds. During this acceleration, the balloon:

a) Moves towards the front of the car
b) Moves towards the back of the car
c) Remains in the same position relative to the car
d) The question doesn't provide enough information to tell.

27. Which of the following steps will *not* increase the sensitivity of the Leung accelerometer?

    a) Reducing its size
    b) Filling it with a fluid denser than air
    c) Increasing the heater temperature
    d) Amplifying the output signal

28. *Moore's Law* states that:

    a) No measurement has more than 6 significant figures
    b) The number of circuit elements that will fit into a square millimeter doubles every two years.
    c) The cost of a mass-produced item depends only on its mass and what it's made of
    d) Big machines are more efficient than small machines

30. Using the strength of the iron-iron chemical bond to predict the strength of structural steel:

    a) Gives us a figure which is at least 10 times too high
    b) Gives us a figure which is at least 10 times too low
    c) Gives us a figure which is accurate to within a factor of 2
    d) Ilustrates the dependence of engineering on knowledge provided by science.

31. In 'Room at the Bottom', we considered an 'automated building site', in which a large number of brick-sized robots would hop out of a truck, scurry around assembling a house, then hop back in the truck and go to the next site. The purpose of this example was:

    a) To show how nanotechnology will revolutionise our lives
    b) To show that many of the goals of nanotechnology require solving problems of agent cooperation, which may be harder than just building small machines
    c) To illustrate Drexler's vision for the nanotechnological assembly of a rocket engine with a more down-to-earth example
    d) To show that nanotechnology can already be applied to practical purposes

32. In designing a bicycle wheel, the number of spokes, the spoke diameter and the spoke length are all examples of:

    a) Functional requirements
    b) Design constraints
    c) Design parameters
    d) Objective functions

33. The 'New Machine' was:

    a) A 1970's rock band
    b) The original name for the Segway
    c) An organization formed by Henry Gantt in 1916
    d) A utopian novel depicting a technocratic future, written by Edward Bellamy in 1899

34. Part of the technocratic solution to the economic problems revealed by the Great Crash was that goods should be valued according to:

    a) the hours of human effort needed to produce them
    b) the Joules of energy needed to produce them
    c) the contribution they would make to human wellbeing
    d) the quantity of scarce raw materials used in their manufacture

35. In the classical economics of Adam Smith, the long-term mass unemployment of the 1930's should be impossible because:

    a) In a free market, wages will adjust themselves downwards until it becomes profitable for an employer to start hiring
    b) Governments can be relied upon to intervene and hire the unemployed
    c) Workers can always increase their productivity by sub-dividing their task into smaller operations, each handled by one worker
    d) Improvements in technology will increase the productivity of each worker, so it eventually becomes profitable to hire more workers.

36. The official colour and symbol adopted by Howard Scott's Technocracy Inc. were:

    a) black, clenched fist
    b) white, pocket calculator
    c) grey, monad
    d) red, five-pointed star

37. According to Sir Karl Popper, the historians and philosophers Spengler, Toynbee, Hegel and Marx all commit the fallacy of:

    a) anthopomorphism
    b) historicism
    c) wishful thinking
    d) idealism

38. Lord Acton's remark:

    "You cannot give a man power over other men without tempting him to misuse it - a temptation which roughly increases with the amount of power wielded, and which very few are capable of resisting. "

    is quoted by Popper to illustrate:

    a) One reason why the technocracy movement failed
    b) How supposed 'laws of human nature' are only valid within particular cultures and particular historical periods
    c) How there are many timeless laws of human behaviour
    d) The importance of selecting rulers who will not be corrupted by power

39. *"Motion pictures will revolutionise our educational system, and in a few years will supplant largely, if not entirely, the use of textbooks."*

This remark of Thomas Edison was quoted in 'The Future' to illustrate:

a) The potential of new technologies to revolutionise the education process
b) The failure of the education system to adapt to new technologies
c) The importance of scepticism regarding the claims of salesmen for new technologies
d) The reasons why textbooks are no longer used in universities

40. The general conclusion of 'The Future' was that:

a) Study of the future is a vital and neglected area
b) Study of the future is futile, since our predictions for the future usually turn out to be reflections of our own era
c) Accurate prediction of the future can only be done by professional futurologists
d) Humanity's future lies in space colonization

41. The prediction that humanity will eventually evolve into two or more sub-species (an effete class of aesthetes and a degraded class of workers) is to be found in:

a) Fritz Lang's movie, *Metropolis*.
b) Aldous Huxley's novel, *Brave New World*
c) H.G. Wells's science-fiction novella, *The Time Machine*
d) All of the above

42. According to 'The Future', the prediction mentioned in Question 41 can be traced to the political theories of:

a) Oswald Spengler
b) Karl Marx
c) Karl Popper
d) Howard Scott

43. In 'The Future', we encounter a quotation from two aviators, written in 1914:

"Airplanes, by linking the Earth, will bring about lasting peace between these close-knit nations."

This statement was quoted to illustrate the general point that:

a) War between nations becomes less likely as they become more techologically advanced
b) The twentieth century saw the replacement of primitive national rivalries by a universal commitment to the use of technology to increase human happiness
c) People have frequently and erroneously believed that the latest technology will bring about a change in the moral character of humanity
d) Technological progress tends to improve communication between different parts of the world

44. The flow of all fluids can be described by:
a) Poisson's equation
b) Laplace's equation
c) the Navier-Stokes equations
d) Schrödinger's equation

45. The basis of micromachining is the creation of small mechanical devices by means of:

    a) The same technology the body uses to make proteins from DNA
    b) The same technology used for the manufacture of silicon chips
    c) The positioning of individual atoms using a scanning travelling microscope
    d) The manipulation of inorganic molecules by highly trained bacteria

46. According to the first lecture on the environment, the net result of photosynthesis is:

    a) The conversion of glucose and oxygen to energy, water and carbon dioxide
    b) The conversion of carbon dioxide and water to energy, oxygen and glucose
    c) The conversion of carbon dioxide, oxygen and water to glucose and energy
    d) The conversion of carbon dioxide, water and energy to glucose and oxygen

47. What technological device appears on the flag of India?

    a) An hourglass
    b) A spinning wheel
    c) A Jacquard loom
    d) A steam engine

48. Hollerith cards are:

    a) A variant of the Tarot pack, used for divination
    b) The union membership cards carried by the first Luddites
    c) Cards with holes punched in them, readable by a machine
    d) Add-on circuit boards used in the first PC's

49. Suppose it's 1 degree Celsius outside, and you want to keep the inside of your house at 20 Celsius. You have a generator which can supply a maximum of 1 kilowatt of power. Given a free choice of technologies (but no additional power), what is the greatest amount of heating power you can supply to the inside of the house?

    a) Slightly less than a kilowatt
    b) Exactly one kilowatt
    c) Slightly more than a kilowatt
    d) Considerably more than a kilowatt

50. The figure below shows two possible designs for nail clippers. The second design is intended to show:

    a) That in the best designs, a separate feature of the artifact corresponds to each functional requirement
    b) That the principle of decomposing design requirements into non-interacting hierarchies does *not* necessarily generate good designs
    c) That the simplest solution to a design problem is not necessarily the best
    d) That imposing too many functional requirements on a design may make the design problem insoluble