Delaware Winter Invitational, 2010
Math and Computer Sciences packet by Mark Pellegrini with contributions from Ben King
Tossups

1) **In 1646, he and his sister converted to Jansenism after his father broke a hip. Despite this, he would continue to practice philosophy until a near-death experience prompted him to give up his work as a scientist. As a theologian, he wrote *The Provinical Letters* and the** *Pensées*, but he is better known for his works in fluid mechanics and in mathematics. This mathematician is, for ten points, what Frenchman who developed a namesake triangle and wager?
ANSWER: Blaise **Pascal**

2) **This data structure was first described in 1953 by H.P. Luhn. In that original description, Luhn also suggested that each entry in this type of data structure incorporate a linked list, a technique known as** chaining. In order to store or retrieve data from this structure, a programmer must use its namesake function on a key to determine where in this data structure to operate. Probing and open addressing are methods to resolve collisions in, for ten points, what kind of data structure that uses a namesake function to store data into a table?
ANSWER: **Hash table** (prompt on hashing; do not accept hashing function)

3) **The name for this concept derives from the Arabic term sifr. Cultures such as the Chinese and the Olmecs made implicit use of it, though the first explicit use occurred with Ptolemy. Despite this, it took four more centuries before** Brahmagupta would treat it like any other number. It is the cardinality of exactly one set, and is considered the start of counting in computer science. This number is for ten points, what integer preceding one?
ANSWER: **Zero**

4) **Charles Flint engineered the triple merger that created this company from Computing Scale Corporation, the International Time Recording Company, and the Tabulating Machine Company. Among the many famous computer systems designed by this company are the System 360, the BlueGene architecture, and the** Deep Blue chess playing machine. Founded by Herman Hollerith, this is for ten points what largest and most profitable computer company in the world?
ANSWER: **IBM** (accept International Business Machines)

5) **In his doctoral thesis, Yuri Matiyasevich ["Mat-ih-yeh-sih-vich"] proved the tenth one of these is impossible. Max Dehn** solved the easiest one, the third, within a year of this list being presented. The first, the continuum hypothesis, is partially solved, while the eighth, the Riemann Hypothesis remains unsolved. First presented to the International Congress of Mathematicians in 1900, this is for ten points what list of unsolved mathematical problems named for its creator?
ANSWER: **Hilbert**'s problems (accept equivalents)

6) **Listen, Syn, Syn-Ack, Fin, and Fin-Ack are some of the states used in this protocol, which uses Nagle's algorithm to reduce congestion. The first version was dubbed Tahoe, and it was followed by Reno, New Reno, and Vegas. Developed by Vint Cerf and Bob**

Kahn, this transport layer protocol ensures that data transmitted over a network arrives in-order and unmodified. Often contrasted with UDP this is, for ten points, what protocol often paired with the Internet Protocol?
ANSWER: **T**ransmission **C**ontrol **P**rotocol

7) **A Hessian one contains the second-order partial derivatives of a function. They were first discussed 2000 years ago in** *The Nine Chapters on the Mathematical Art*, a Chinese treatise where they were used to solve simultaneous equations. Basic operations on these mathematical constructs are addition, scalar multiplication, non-commutative multiplication, and transposition. This two dimensional tensor is, for ten points, what mathematical construct where numbers are arranged in rows and columns?
ANSWER: **Matrix**

8) **The first version of this programming language, targeted to the IBM 704, contained Dimension, Equivalence, and Frequency statements. The** 1966 version was standardized by ANSI and included a real type, which made it useful for scientific programming. Today, the 1977 and 1990 versions are the most widely used. Devised by John Backus, this is for ten points what first high level programming language whose name refers to its ability to manipulate formulas?
ANSWER: **Fortran**

9) **Anaxagoris worked on this problem while in prison, and in 1667 James Gregory published a flawed proof in *Vera Circuli et Hyperbolae Quadratura*. As a consequence of the** Lindemann-Weierstrass theorem, this problem is now known to be impossible. The goal of this problem is to take a finite number of steps using a compass and straight-edge and construct one geometric shape with exactly the same area as another. This is, for ten points, what ancient mathematical problem involving a square?
ANSWER: **Squaring the circle** (accept clear-knowledge equivalents)

10) **His mother claimed that his death was caused by his carelessness around lab equipment, but most people believe that he committed suicide by eating an apple** poisoned with cyanide. Two years earlier, he had been convicted of gross indecency for his homosexual affair with Arnold Murray. A cryptanalyst at Bletchley Park during World War II, this is for ten points, what British mathematician whose namesake theoretical machine models computer behavior?
ANSWER: Alan **Turing**

11) **Loop transformation, constant propagation, and interprocedural analysis are common optimizations applied by one of these software tools, which typically contains a parser, lexical analyzer, and semantic analyzer.** Grace Hopper designed the first, while Fortran's was the first complete one. The back-end of one of these tools typically consists of an architecture-specific code generator. CC, ICC, and GCC are examples of, for ten points, what type of program which turns source code into machine code?
ANSWER: **Compiler**

12) **Doug Lenat's Automated Mathematician may have rediscovered this problem, which was first described in a 1742 letter written by its namesake. In order to generate publicity for** Apostolos Doxiadis's book about this problem, his publisher offered a million dollars to anyone who could prove it. Numerous mathematicians have tried, including Vinogradov, Hardy, and Littlewood, but no one has succeeded. For ten points, this is what conjecture which states that every even number greater than 2 can be expressed as the sum of two prime numbers?
ANSWER: **Goldbach conjecture**

13) **Julius Edgar Lilienfeld patented this device in 1925, as did Oskar Heil in 1934. John Pierce coined the name, though much of the early research and development can be credited to** Wiliam Shockley. The bipolar junction variety was used heavily in the 1960s, but has largely been replaced by field effect variety. The key component in all modern electronics, this is for ten points what microscopic device which can amplify or switch electric signals?
ANSWER: **Transistor**

14) **One practical application of this mathematical theorem is to reduce the complexity of circuit design, and to allow the construction of any circuit using only** Nand gates. To apply this theorem, take a logical statement, invert its inputs and outputs, and change all Ands to Ors and all Ors to Ands. This theorem is named for Augustus, the British mathematician who first formally defined it. Stating that not P or Q equals not P and not Q, this is for ten points what fundamental theorem in boolean logic?
ANSWER: **De Morgan**'s theorem

15) **Almost all modern computers implement this data type using the IEEE 754 specification, which for 32 bit** precision specifies a sign bit, followed by an 8 bit exponent and a 23 bit mantissa. Positive and negative zero are distinct values in this data type, which uses binary fractions to store rational numbers. 64 bit precision values of this data type are known as doubles. This is for ten points what data type often contrasted with fixed point?
ANSWER: **Float**ing point

16) **In 1967, along with John-Paul Sartre, this mathematician presided over two sessions in which U.S. actions in Vietnam were put on trial in a mock-court. He was appointed a professor at** City College of New York in 1940, but lost that position in a well-publicized case during which a judge declared him "morally unfit" to teach. His namesake paradox shows that naive set theory contains a paradox when dealing with universal sets, while his namesake teapot refutes the idea that the burden of proof is on skeptics of religious ideas. This is for ten points what British philosopher and mathematician who along with Alfred North Whitehead co-authored *Principia Mathematica*?
ANSWER: Bertrand **Russell**

17) **Taylor's theorem is a generalization of the first part of this theorem, which was first published by James Gregory in restricted form, and first published in its entirety by** Isaac Barrow. Stokes's theorem is another generalization of this theorem which applies to non-Euclidean spaces. Relating two problems previously thought to be unrelated, the tangent problem

and the area-under-the-curve problem, this is for ten points what theorem in Calculus which relates differentiation and integration?
ANSWER: **Fundamental theorem** of **Calculus**

18) **He eschewed using computers, preferring to write all his documents long-hand in handwriting so unique it was later turned into a font. An advocate of structured programming, he penned a 1968 letter** "Goto Considered Harmful." To provide mutual exclusion and prevent race conditions, he invented semaphores, for which he was awarded the 1972 Turing Award. Creator of a namesake shortest path algorithm, this was for ten points, what Dutch computer scientist?
ANSWER: Edsger **Dijkstra**

19) **John Wallis is credited with popularizing the lemniscate to symbolize it, and Leopold Kronecker developed a form of constructivism without it. While many fields of mathematics only use this concept implicitly, set theory uses it in both** ordinal and cardinal forms. Much of the early set theory work on this concept was done by George Cantor, who used aleph numbers to represent their cardinality, starting with aleph-null. The centerpiece of Hilbert's Paradox, this is for ten points what concept of unboundedness?
ANSWER: **Infinity**

20) **A 1973 lawsuit centering on patents related to this device found that several key ideas in its operation had been copied from the Atanasoff–Berry Computer. Built under the code name "Project PX," this computer was transferred to the Ballistic Research Laboratory in Aberdeen, where it was used to** compute firing tables. John Mauchly and J. Presper Eckert designed this computer, which used over 17,000 vacuum tubes. Later succeeded by the EDVAC, this describes for ten points, what first general purpose electronic computer?
ANSWER: **E**lectronic **N**umerical **I**ntegrator **A**nd **C**omputer

21) **Douglas Engelbart created the first one of these devices in 1963. Despite John C. Dvorak's famous prediction that nobody would want them, they became extremely popular after being bundled with the original** Apple Macintosh. Now available in optical and mechanical varieties, and commonly featuring featuring two or three buttons, this is for ten points what computer accessory used for pointing that is named for a rodent?
ANSWER: Computer **mouse**

22) **He patented the first confocal microscope in 1957 and the first head-mounted graphical display in 1963. He partnered with Seymour Papert to create the first logo programmed turtle bot. He has lately feuded with Hugh Loebner over Loebner's annual** Turing Test prize. Winner of the 1969 Turing award and a long-time professor at MIT, this is for ten points what father of artificial intelligence?
ANSWER: Marvin **Minsky**

23) **It may be shown that the product of this and a matrix is its own Hermitian transpose, and that the condition number of a matrix is the product of the matrix norm of that matrix and of this. Like other matrix transformations, this is unique for a given matrix. Like the**

transpose, it returns the original matrix when performed twice, and always exists**.** Developed by E.H. Moore and Roger Penrose, this is what generalized matrix transformation that shares some of its properties with a namesake concept of nonsingular matrices?
ANSWER: Moore-Penrose **pseudo inverse** (accept **generalized inverse** early)

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Bonuses

1) Name these phrases used in proofs, for ten points each
[10] Equivalent to "necessary and sufficient", this logical connective indicates that for two statements P and Q, P implies Q and Q implies P.
ANSWER: **If and only if**
[10] This three-letter acronym signifies the completion of a proof. English alternatives include the black square of TeX and the black rectangle of Unicode.
ANSWER: **Q**uod **e**rat **d**emonstrandum
[10] Distinct from handwaving in that it is valid though nonconstructive, this phrase is a facetious reference to the use of category theory in proofs.
ANSWER: **Abstract nonsense** (accept **general abstract nonsense** or **general nonsense**)

2) Name some things about microprocessors, for ten points each
[10] Often contrasted with TTL and NMOS, almost all microprocessors sold today use this fabrication technology.
ANSWER: **C**omplementary **m**etal–**o**xide–**s**emiconductor
[10] One approach to the memory wall problem is to use multiple levels of these, which come in data and instruction varieties.
ANSWER: **Cache**s (Do not accept or prompt on RAM or random access memory)
[10] This law, named for a former chairman of Intel, is the observation that transistors double in density every two years.
ANSWER: **Moore**'s law

3) They are capable of efficiently solving quadratic unconstrained binary optimization problems. For ten points each
[10] This is what type of device which uses superposition and entanglement?
ANSWER: **Quantum computer**
[10] Information in quantum computing is measured in these units
ANSWER: **Qubit**s
[10] Quantum computers use these kinds of junctions, whose namesake effect causes current to flow between two superconductors separated by a thin barrier. They are named for the physicist who predicted that effect.
ANSWER: **Josephson** junctions (Accept **Josephson** effect)

4) Name these mathematicians, for ten points each
[10] In addition to a namesake conjecture on 3-manifolds and research on the three-body problem, he was the first to analyze the Lorentz transformations as a mathematical group. Some believe that he would have discovered special relativity if Einstein had not.
ANSWER: Henri **Poincaré**
[10] Often writing under the pseudonym "Monsieur Le Blanc", she wrote several papers on elasticity and number theory. A type of prime number is named for her.
ANSWER: Sophie **Germain**

[10] This Persian with a namesake quadrilateral was the first to work on non-Euclidean geometry and the exact solving of cubic equations. He also developed the precursor to the modern Iranian calendar, known as the Jalali calendar.
ANSWER: Omar **Khayyám**

5) You have a container and items of varying weight and value. Your container can hold a limited weight, and you want to put the greatest value possible into the container. For ten points each
[10] This describes what mathematical problem?
ANSWER: **Knapsack** problem or (Accept **rucksack** problem or **backpack** problem)
[10] This Stanford computer scientist, whose life story inspired the film *Good Will Hunting*, devised an algorithm to solve the knapsack problem.
ANSWER: George **Dantzig**
[10] Dantzig's knapsack algorithm is this kind of algorithm, which repeatedly makes the best short-term choice in the hope of achieving the best long-term result.
ANSWER: **Greedy** algorithm

6) Name these configurations used in computer networking, for ten points each
[10] In this type of network topology, a single channel is shared between multiple hosts
ANSWER: **Bus**
[10] In this type of network topology named for a flower, all the devices connect in "front to back" style. USB devices may follow this configuration.
ANSWER: **Daisy chain**
[10] This type of network is similar to a daisy chain, except that the last host has a connection that wraps back around to the first.
ANSWER: **Toroid**al network

7) Name these concepts in number theory, for ten points each
[10] According to this theorem by the other Sun Tzu, for any set of K co-primes and K corresponding integers, there is a unique X that is simultaneously congruent to each integer modulo its corresponding co-prime.
ANSWER: **Chinese Remainder** theorem
[10] This recent theorem named for a Brit and an Australian states that the sequence of primes includes arbitrarily long integer sequences.
ANSWER: **Green-Tao** theorem
[10] This conjecture states that there are infinitely many pairs of prime numbers of the form P and P+2.
ANSWER: **Twin prime** conjecture

8) Name some things from statistics for ten points each
[10] This is a common function in statistics which is denoted using an exclamation point.
ANSWER: **Factorial**
[10] This statistical theorem, formulated by and named for a British Presbyterian minister, states that the probability of an event A given event B is the probability of B given A, times the probability of A, divided by the probability of B.

ANSWER: **Bayes** theorem
[10] This theorem states that a large number of independent identically distributed random variables will have an normal distribution.
ANSWER: **Central limit** theorem

9) Name some things about the history of the Internet, for ten points each
[10] Almost synonymous with the Internet is this hypertext service invented by Tim Berners-Lee.
ANSWER: **W**orld **W**ide **W**eb (accept the **web**)
[10] This predecessor of the modern internet was the first packet switched network in the world. It was created by the Department of Defense and used IMPs as gateway devices.
ANSWER: **ARPA**NET or **Advanced Research Projects Agency Network** (Do not accept DARPANET)
[10] Vannevar Bush conceived this Internet predecessor in which books and documents were compressed into microfilm and stored on a desk-sized reader.
ANSWER: **Memex**

10) Need to keep a secret? Then you should have no problem naming these things from cryptography for ten points each
[10] This kind of encryption scheme uses the same key for encrypting and decrypting data.
ANSWER: **Symmetric** key cryptography
[10] ElGamal encryption is one example of this type of encryption scheme, which uses different keys to encrypt and decrypt.
ANSWER: **Public-key** cryptography (prompt on **asymmetric** key cryptography)
[10] In symmetric cryptography, both parties must agree on a key. They may accomplish that by using this classic doubly eponymous algorithm.
ANSWER: **Diffie-Hellman** key exchange algorithm

11) Name some things about keyboards, for ten points each
[10] Belgian software developer Pieter Hintjens has started a campaign to remove this key from keyboards. Most people consider text written using this key to be shouted.
ANSWER: **Caps lock** key or button
[10] When this modifier key is pressed, it replaces the function of some keys with their secondary functions. It is sometimes called the meta key.
ANSWER: **Alt** key or button (accept **Option** key or button)
[10] This rarely used key is typically located between print screen and break. It is usually one of three keys that have a light.
ANSWER: **Scroll lock** key or button

12) Its namesake wrote that "I have discovered a truly marvelous proof of this, which this margin is too narrow to contain." For ten points each
[10] This describes what famous problem in mathematics that remained unproven for centuries?
ANSWER: **Fermat's Last Theorem**
[10] Fermat's Last Theorem was finally proven in 1995 by what Princeton mathematician?
ANSWER: Andrew **Wiles**

[10] Wiles was able to prove Fermat's last theorem by partially proving what conjecture relating to elliptical curves?
ANSWER: **Taniyama–Shimura** conjecture (accept: **Modularity theorem**)

13) Name some data structures for ten points each
[10] In this simple data structure, data is added to the end and removed from the front. They are typically implemented with circular buffers or linked lists.
ANSWER: **Queue** (Accept **F**irst **I**n **F**irst **O**ut**)**
[10] In this type of data structure, a unique key is used to access data elements. In C++, they are known as maps.
ANSWER: **Associative array** (Accept: **Dictionary**; do not accept or prompt on multimap)
[10] Rudolf Bayer invented this type of balanced binary search tree in which all nodes are assigned one of two colors
ANSWER: **Red-black** tree

14) It is measured where a three dimensional object subtends a point. For ten points each
[10] What is this spacial equivalent of an angle?
ANSWER: **Solid angle**
[10] Solid angle is often measured in what units, a dimensionless measure equal to 3,282.8 square degrees?
ANSWER: **Steradian**s
[10] Solid angle is symbolized with what Greek letter?
ANSWER: **Omega**

15) Name some things related to operating systems for the stated number of points
[10] For ten points, this central component of most operating systems allocates resources and provides hardware abstraction
ANSWER: **Kernel**
[5,5] Kernels are typically subdivided into these two types. The larger type includes device drivers, protocol stacks, and file systems in the kernel itself, while the smaller variety puts them in user space. Name them for five points each.
ANSWER: **Monolithic** kernels
Microkernels (Accept **exokernel**s)
[10] For ten points, this is perhaps the best known microkernel. A GNU tool, it has been under development for 20 years.
ANSWER: GNU **Hurd**

16) Name some important concepts from computing theory, for ten points each
[10] This doubly-eponymous theorem states that if an effectively calculable algorithm exists, it can be represented by recursion, by a Turing machine, or by lambda calculus, all of which have been proven to be equivalent.
ANSWER: **Church–Turing** thesis (accept **Church–Turing** hypothesis)
[10] "Effectively calculable" means that something can be calculated by an algorithm in finite time. However, in 1936 Turing solved this related problem, by showing that it is impossible to know beforehand whether or not that will happen for all possible inputs to an algorithm.

ANSWER: **Halting problem**
[10] The halting problem is closely related to this mathematical problem posed by David Hilbert in 1928, which asks if an algorithm can be created which takes a mathematical language and statement as an input, and returns true if the statement is true and false if the statement is false.
ANSWER: **Decision problem** or **Entscheidungsproblem**

17) Name some things about fractals for ten points each
[10] Fractals can be generated using this set, named for the mathematician who coined the word fractal, which is defined by the equation Z sub N plus one equals Z sub N squared
ANSWER: **Mandelbrot set**
[10] This fractal is created in a recursive process by taking existing triangles, removing the middle-third of each side, and replacing the missing section with a new triangle.
ANSWER: **Koch snowflake** (accept: **Koch star**)
[10] This self-similar tiling arrangement consists of a triangle containing an infinite number of smaller triangles. It is named for its polish discoverer.
ANSWER: **Sierpinski triangle** (accept: **Sierpinski gasket** or **Sierpinski Sieve**; do not accept **Sierpinski carpet**)

18) Name these common types of malicious computer software for ten points each
[10] The goal of this spyware class is to capture usernames, passwords, and other information that is typed into a computer
ANSWER: Key**logger** (accept **keystroke logger**, **keyboard logger**, and other equivalents)
[10] This software automatically replicates itself from one computer to another connected by a network
ANSWER: **Worm** (do not accept **virus**)
[10] This type of software appears innocuous but covertly opens a machine to intruders.
ANSWER: **Trojan** horse

19) Name these formulas from mathematics that are named for the mathematicians that discovered them, for ten points each
[10] This formula for the area of a triangle was first published in *Metrica* by its Egyptian discoverer
ANSWER: **Heron**'s formula (Accept **Hero**'s formula)
[10] This formula, named for its Indian discoverer, calculates the area of any quadrilateral
ANSWER: **Brahmagupta**'s formula
[10] This formula gives the real and complex parts of a complex exponential in terms of trigonometric functions.
ANSWER: **Euler**'s formula

20) Name these curves for ten points each
[10] This is the curve formed by the intersection of a plane with a cone
ANSWER: **Hyperbola**
[10] Y to the fourth power minus X to the fourth power equals X times Y produces this curve, named by Cundy and Rollett for the Buddhist symbols it resembles.
ANSWER: **Swastika** curve

[10] A point on a circle that is rolling around another circle of equal radius will follow this curve
ANSWER: **Limaçon** ["Lim-ah-sahn"]

21) Name some things about Supercomputing, for ten points each
[10] Supercomputers are ranked in the Top 500 list according to this benchmark, which measures their ability to perform dense linear algebra
ANSWER: **Linpack**
[10] The current fastest Supercomputer in the world is Jaguar, located at this Department of Energy facility in Tennessee.
ANSWER: **Oak Ridge** National Laboratory
[10] Almost all supercomputers use this communication library designed for distributed memory architectures. Bill Gropp won the 2008 Sidney Fernbach award for developing it.
ANSWER: **M**essage **P**assing **I**nterface