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April 22, 2015

Midterm

Multiple Choice [2 points each]

1) a -> De Morgan's Law
2) d -> Exclusive Disjunction
3) e -> Transposition Logic (Contrapositve)
4) a -> Union (Venn Diagram) Everything that is in either of the sets
5) c -> Intersection (Venn Diagram) Only the things that are in both of the sets
6) e -> The function is neither one-to-tone or onto because values less than -1 on the y-axis are never used. It passes the horizontal line test, but since possible y-values belong to the set of **R** and f(x)∋**R**, not all possible values are used
7) a, c, d -> 20 mod 60 = .333; all 80 mod 60 has remainder of .333 as well as 380 and 800 mod 60.

Using the Grey Matter a Little Bit [4 point each]

8) Nothing much can be said about Steve getting a scholarship. Although the argument is valid, it has no bearing on whether any of the statements in the argument are true. It is a Modus Ponens argument ($P \to Q \wedge Q \to S$). Steve could have gotten a scholarship by different means (i.e. he got a scholarship because he scored high on a written test) other than by training hard (or not) and by winning the game (or not). It is a one direction argument; therefore Steve could have gotten a scholarship by training hard and winning the game, but also by other means..
For example, if the argument were to be an "If and only if" (Biconditional proposition ↔),

then you could say that Steve got a scholarship only because he trained hard and won the game, but it's not "if and only if"; therefore, nothing much can be said about Steve.

9) a) 365(days) x 10(years) = 3650 days;
3650 %(mod) 7(days of week) = 3;
Therefore, 3 days after Thursday would be on a **Sunday**.

b) 365 * 10 = 3650;
3650 + 3 = 3653; // Plus 3 leap years
3653 % 7 = 6;
Therefore, 6 days after Thursday would be on a **Wednesday**.

c) 3000 - 2015 = 985 years;
985 / 4 = 246 possible leap years;
985 * 365 = 359525 days;
246 - 8 = 238 days extra; // -8 because there are 8 years that are NOT leap years (2100, 2200, 2300, 2500, 2600, 2700, 2900, 3000)
359525 + 238 = 359763 total days;
359763 % 7 = 5;
Therefor, 5 days after Thursday would be on a **Tuesday**.

10) $$\frac{f(n)}{g(n)} = \frac{n^4 + 3n^3 + 6n^2 + 3n + 1}{n^4} < \frac{n\hat{}4 + 3n^4 + 6n^4 + 3n^4 + n^4}{n^4} = 14$$

Choose C = 14, k = 1

Thus, $n^4 + 3n^3 + 6n^2 + 3n + 1$ is $O(n^4)$

because $n^4 + 3n^3 + 6n^2 + 3n + 1 \leq 14n^4$ whenever $n > 1$ $(n > k)$

11)
```
float StandardDeviation(int numbers[ ], int size) {
    float sqr_sum = 0; float mean = 0;
    for (i=0; i<size; i++)
        sqr_sum += numbers[i]*numbers[i];
    for (i=0; i<size; i++)
        mean += numbers[i];
    mean /= size;
    return sqrt(sqr_sum/size – pow(mean, 2)); }
```

The Big-Theta runtime in this case is n^2 and the Space usage is n because of the pow and square root functions.

if n = 100	# of Iterations	= 1,000,000
	Runtime	= n^2
	Space Usage	= n

Short Answer (Maybe not so much) [4 point each]

12)

A	B	I	$A \wedge B$	$\neg (A \wedge B)$	$\neg A \vee \neg B$
T	T	|	T	F	F
T	F	|	F	T	T
F	T	|	F	T	T
F	F	|	F	T	T

13) I would use the Induction Proof by Base Case = 1 to prove the statement, and the Induction proof by n = k + 1 to disprove the statement.

Let n = "I just ate", k = "Therefore there is no world hunger"

<u>Proof by Base Case: 1</u> (Prove)
Prove n = k;
If n = 1, then k = 1; Therefore n = k is true by Base Case: 1

<u>Proof by Induction</u> (Disprove)
Assume true for n = k;
Let n = k + 1;
If n = 1, then k = 2; Therefore $n \neq k$. Disproving it by Induction.

14) Proof by
<u>Base Case: 1</u>
Let $n = 1 \Rightarrow 1 = [\, n(n + 1) \,] / 2 \Rightarrow 1 = 2 / 2 \Rightarrow 1 = 1$ ✓

<u>Induction Step</u>
Assume true for n = k
Assume true for n = k +1 $\Rightarrow n = [\, k (k + 1) \,] / 2$ is true

$1 + 2 + \ldots + k + (k + 1) = [\, (k + 1) (k + 2) \,] / 2$
$[\, k (k + 1) \,] / 2 + (k + 1) = [\, k^2 + 3k + 2 \,] / 2$
$(k / 2)^2 + (3 / 2)k + 1 = (k / 2)^2 + (3 / 2)k + 1$ ✓

Alternative, one can use the Direct Proof to prove that

$1 + 2 + 3 + \ldots + (n-2) + (n-1) + n = [\, n\,(n+1)\,] / 2$

15)

3	1	0	3	0		
625	125	25	5	1	Multiply by the number above	
1875	125	0	15	0	⇒	1875 + 125 + 0 + 15 + 0
					=	2015

Therefore, **31030_5** is **2015_{10}**

16) $0 \equiv (3^*a_1 + a_2 + 3^*a_3 + a_4 + 3^*a_5 + \ldots + a_{10} + 3^*a_{11} + a_{12})$ **mod** 10

```
bool ValidateCode(int upc_code[12]);
{
      int sum = 0;
      int checkdigit = 0;
           for (int 1=0; i < 12; I++)
           {
                if ( i % 2 == 0)
                     sum += ( 3 * upc_code[i]);
                else
                     sum += upc_code[i];
           }
      checkdigit = sum % 10;
           if (checkdigit == 0)
                return true;
           else
                return false;
}
```

17)

18)

```
#include <iostream>
#include <string>

using namespace std;

int main()
{
    string msg;
    int  length, before = 0;

    cout << "Enter your phrase: \n";
    getline(cin, msg);

    length = (int)msg.length();

    //  TO DECRYPT IT

    for (int element = 0; element < length; element++)
    {
```

```
        if(isalpha(msg[element]))
        {
            msg[element] = toupper(msg[element]);
            cout << (char)(((((int)msg[element] - 65 - before) + 26) % 26) +65);
            before = (int)msg[element] -65;
        }
    }

    cout << endl;

    return 0;
}
```