**1) The following are supposed to be examples of CMAP-expressions:**

```
1.   L = hypot(!A);
2.   A * B = C;
3.   A = getnum(C, D, E);
4.   getnum("Input A", A);
5.   f(x,y,z) = x^2*sin(y*z);
6.   plot(x,a,b,a*2^2+b);
7.   defmat(A[3], 2,1,3,0);
8.   view(A, B, C);
```

*ONE of the following statements may be FALSE. Which one?*

a) Line 1 assigns $\sqrt{\sum A^2_{i,j}}$ to L.
b) Line 2 has syntax error(s).
c) Line 3 has bad function arguments.
d) Line 4 serves no real purpose.
e) Line 5 has syntax errors.
f) Line 8: A, B, C must be existing variables.
g) Line 6 seems to have a typo error.
h) Line 7 has executable error(s).

i) None of the above.

**2) Consider the following program:**

```
1.   float G = 1, float H = 1
2.   main()
3.   {
4.      float H = 3, K = 4;
5.      print(f(G, h), G, H, K);
6.   }
7.   f(float G; float H) {
8.      G = G + 1;
9.      H = H + 1;
10.     K = 1;
11.     print(^,G, H, K);
12.  }
```

*ONE of the following statements may be FALSE. Which one?*

a) Line 1 has syntax error(s).
b) Line 4 declares local variables.
c) Line 5 has a typo error.
d) Line 7 has syntax error(s).
e) If all errors are properly corrected, the output would be:

2 4 1 0 2 4 1

f) None of the above.

**3) Consider the following program:**

```
main() {
    A = 2; B = 4; C = 0; SUM = 1;
    switch(A)
    {
       case 2:
            if(C){ C=1; SUM=SUM-C;}
            else { C=-1;SUM=SUM+C;}
       case 5:
            SUM = SUM + A + B + C;
            break;
       default:
            A=1; B=3; C=-1; SUM=1;
            Break;
    }
    print (^, A, B, C, SUM);
}
```

*Its execution will give the following output:*

| | | | | |
|---|---|---|---|---|
| a) | 1 | 2 | 1 | 1 |
| b) | 2 | 4 | -1 | 5 |
| c) | 2 | 4 | 0 | 1 |
| d) | 2 | 4 | 1 | 7 |
| e) | 2 | 4 | -1 | 0 |

f) None of the above.

**4) Consider the following program:**

```
float a = 4, b = 5, c = 3;
mat A[2], B[2];

main() {
    float a = 1, b = 2;
    c = 4;
    defmat(A,3,4);
    defmat(B,5,6);
    F(A, B[2],a,b);
    print(^, A[1], B[2], a, b, c);
}

F(mat X, float B, float a, float b)
{
    a = 2; b = 3; c = 0;
    X[1] = 1; B = 5;
}
```

*Its execution will give the following output:*

1 6 1 2 0

**5) Consider the following program:**

```
1.   main() {
2.      float a = 1;
3.      b = 2;
4.      f(a, b);
5.      print(a, b);
6.   }

7.   f(float a, float b) {
8.      float T = 0;
9.      if(a < b){ T=a; a=b; b = T;}
10.     print(a, b, T);
11.  }
```

*Its execution will give the following output:*

| | | | | | |
|---|---|---|---|---|---|
| a) | 2 | 1 | 1 | 2 | 1 |
| b) | 1 | 2 | 1 | 2 | 1 |
| c) | 2 | 1 | 2 | 1 | 2 |
| d) | 1 | 2 | 1 | 1 | 2 |
| e) | 2 | 1 | 1 | 1 | 1 |
| f) | 1 | 2 | 2 | 1 | 1 |

g) None of the above.

2 1 1 1 2

**6) Consider the following program:**

```
main()
{ F = (A=2^2*2) + 5(C=(B=2)*2+1) *
    (D=A/B*(E=hypot(3,4)^2/5)==5);
  X = 2*(C<3) + 3*(B==2)+2*(D>3);
  print(^, A, B, C, D, E, X);
}
```

8 2 5 0 5 3

*Its execution will give the following output:*

| | | | | | | |
|---|---|---|---|---|---|---|
| a) | 8 | 2 | 6 | 9 | 5 | 5 |
| b) | 16 | 2 | 5 | 0 | 5 | 7 |
| c) | 8 | 2 | 5 | 5 | 1 | 5 |
| d) | 16 | 2 | 5 | 9 | 1 | 5 |
| e) | 8 | 2 | 5 | 0 | 5 | 3 |

f) None of the above.

**7) The following program is supposed to get user's input of a value 'A' greater than zero, and then divide it repeatedly by 2 to see if it will eventually reduce to zero.**

*ONE of the following statements may be FALSE. Which one?*

a) Line 6 has logical error(s).

```
1.   main() {
2.      N = 0;
3.      do
4.      {
5.        A = getnum();
6.      } while (A < 0);
7.      while (A > 0)
8.      {
9.          A = A/2;
10.         N = N+1;
11.     }
12.     print(N);
13.  }
```

b) 'N' counts the number of times of division.
c) Line 7: Logical expression '(A>0)' can be replaced by (A) in this program.
d) 'A' in line 7 remains non-zero and hence the loop is endless.
e) Function getnum() should preferably have a prompt message.
f) The final value of 'N' depends on the value 'A'.
g) None of the above.

8) Consider the following program:

```
1.   main()
2.   {
3.   print(f(1,9,2));
4.   }

5.   f(float M, N, K)
6.   {
7.   float I, Sum = 0;
8.   for(I = M, I<= N, I = I+K)
9.      {
10.     Sum = Sum + I;
11.     if(I>=N-3){print(I,Sum);}
12.     }
13.  }
```

*ONE of the following statements may be FALSE. Which one?*

a) Line 5 has syntax error(s).
b) Line 8 has syntax error(s).
c) Line 11 has a typo error.
d) After correcting all the errors, execution of f() will finally give I = 11 at line 13.
e) After correcting all the errors, execution of the program will give this output:
7 16 9 25 0
f) None of the above.

9) Consider the following program that adds two matrices:

```
1.   float I = 2, J = 3;
2.   main() {
3.   defmat(X[I,J],1,2,3,4,5,6);
4.   defmat(Y[I,J],0,2,1,0,1,3);
5.   zero(S[I,J]);
6.   Add(X,Y,S,I,J);
7.   print(I,J,S[2,2]);
8.   }

9.   Add(mat A, mat B, mat C,
         mat M, mat N)
10.  | // Add matrices A, B giving C;
11.  float I, J;
12.  for(I=1; I<=M; I=I+1)
13.     {
14.     for(J=1;J<=N;J=J+1)
15.        {
16.        C[I,J]=A[I,J]+B[J,I];
17.        }
18      }
19.  }
```

*ONE of the following statements may be FALSE. Which one?*

a) There are syntax errors in line 3, 4, 5.
b) Bad type declaration in line 9.
c) Logical and/or executable error in line 16.
d) Line 11 is necessary for the program to work properly.
e) After correcting all the preceding errors, program execution will give this output:
2 3 6
f) Function Add() returns 0.
g) None of the above.

10) Consider the following program:

$$\left.\begin{aligned} A_{11}X_1 + A_{12}X_2 + A_{13}X_3 &= B_1 \\ A_{21}X_1 + A_{22}X_2 + A_{23}X_3 &= B_2 \\ A_{31}X_1 + A_{32}X_2 + A_{33}X_3 &= B_3 \end{aligned}\right\} \text{ and } C = A^{-1}$$

where the units of Xi, and Bi are as follows:

| Variables | Units |
|---|---|
| $X_1$ | kN |
| $X_2$ | m |
| $X_3$ | kN.m |
| $B_1$ | kN.m |
| $B_2$ | m |
| $B_3$ | Radians |

*ONE of the following statements may be FALSE. Which one?*

a) The unit for $C_{12}$ in kN/m.
b) The unit of $C_{21}$ is 1/kN.
c) $C_{31}$ is dimensionless.
d) The unit of $C_{33}$ is kN.m.
e) The unit of $C_{13}$ is m.
f) The unit of $C_{22}$ is m/m.

g) None of the above.

11) The following program is supposed to search for the smallest element of an array, and then place it into the first cell of the array by swapping the contents of the two cells.

```
1.   main() { //Sample data
2.      defmat(A[N=5],3,-2,4,-6,1);
3.      MinSwap(A, N);
4.      print(A);
5.   }

6.   MinSwap(mat A, mat N) {
7.      float I=J=1,T,Min = A[1];
8.      do {// Search minimum element
9.          if(Min<A[I]){
10.         Min = A[I]; I = J;
11.         }
12.         I = I+1;
13.     } while(I <= N);
14.     // Swap the elements
15.     A[1]=A[J]; T=A[1]; A[J]=T;
16.     return Min;
17.  }
```

*ONE of the following statements may be FALSE. Which one?*

a) Line 6 has error(s).
b) Line 9 has logical error(s).
c) Line 10 has logical error(s).
d) Line 15 has logical error(s).
e) After correcting the errors, execution of MinSwap() will finally give at line 16: I = 6, J = 3, Min = -6
f) After correcting the errors, execution of the program will output array 'A' that has the following elements: -6 -2 4 3 1

g) None of the above.

12) The following program attempts to fit the parabola $y = C_1+C_2x+C_3x^2$ to the following three points:

| x | -2 | 1 | 2 |
|---|---|---|---|
| y | 10 | 6 | 30 |

(Line numbers are added for reference only)

*ONE of the following statements may be FALSE. Which one?*

a) The program has no syntax error(s).
b) Data for {B} is correct.
c) Data for [A] is correct.
d) The fitted parabola should pass through all three points
e) Line 6 plots the fitted parabola.
f) solve() is appropriate for this problem.

```
6.      plot(x,-2,2,B[1]+B[2]*x+
                    B[3]*x^2);
7.      }
```

unique solution,
(3 equation 3 unknown so 1 sol)

13) A particle at position {A} is supported by 3 cables which are anchored at 3 points specified by the array [B]. The particle is subject to a known resultant force {R}. The following program is supposed to compute the tensions in the 3 cables:

```
1     main()
2     {
3        mat A[3], B[3,3], R[3];
         // Input components x,y,z
4        view(A,B,R);
5        CableForces(A, B, R);
6        print(R);
7     }

8     CableForces(mat P,mat C,mat R)
9     {// Set up equilibrium equations
10     // and solve for cable tentions
11       float i;
12       zero(D[3,3]);
13       for(i = 1; i<= 3; i=i+1)
14       {
15          !V=(Ci=C(i)-P)/hypot(!Ci);
16          !D(i) = V;
17       }
18       solve(S,D,!R = -R);
19    }
20
```

*ONE of the following statements may be FALSE. Which one?*

a) User's input for arrays A, B, and R takes place at run-time.

b) Ci at line 15 is a unit vector. → V is unit vector

c) Arrays P, C, R in CableForces() are local names of arrays A, B, R of main().

d) When CableForces() is executed, it creates global arrays D, V, Ci.

e) Row i of matrix D contains the direction cosines of the cable i. ✗

f) Computed cable tensions are stored in R.

---

g) None of the above.

*ONE of the following statements may be FALSE.*

```
1.    main()
2.    {// Set up and solve [A]{C}={B}
3.    defmat(B[3], 10, 6, 30);
4.    defmat(A[3,3],1,-2,4,
                1,1,1,    1,2,4);
5.    solve(S, !U = A, !C = B);
6.    plot(x,-2,2,B[1]+B[2]*x+
                B[3]*x^2);
7.    }
```

solution is in C

not in B

g) None of the above.

---

14) Consider the following program that computes, in various ways, the first derivative of the function f(x, y, t) at the point (xo, yo, to):

```
main()
{
   xo = 0.5; D = 0.001;
   yo = 1.2; to = -0.15;
   Df1 = (f(xo,yo+D,to)-
          f(xo,yo,to))/D;
   Df2 = (f(xo,yo+D,to) -
          f(xo,yo-D,to))/D;
   Df3 = deriv(y,yo,f(xo,y,to));
   Df4 = deriv(t,to,f(xo,yo,t));
   print(^,Df1, Df2, Df3, Df4);
}


f(float x, float y, float t)
{
   return y*cos(x)*exp(t*x);
}
```

*ONE of the following statements may be FALSE. Which one?*

a) The program has no syntax error(s)
b) Df1 gives $\partial f / \partial y$.
c) Df2 also gives $\partial f / \partial y$, but the result is, generally, more accurate than Df1.
d) Df3 gives $\partial f / \partial y$ using the built-in function.
e) Df4 gives $\partial f / \partial t$.
f) If D is very small, the computed derivatives may become inaccurate. → may cause errors

---

g) None of the above.

---

15) Consider the following program that computes the gradient and total differential at point {Xo} of function F({X}):

```
1     main()
2     {
3     defmat(Xo[4], 1, 1.5, 1.2, 3);
4     zero(G[4]); // The gradient
5     grad(Xo,G,F(Xo)); // G at Xo
6     print(Xo, G);
7     defmat(Dx[4],0.01,0.2,0.15,
          0.2); // Changes in Xo
8     print(^^, F(Xo), DF = !G*Dx);
9     }

10    F(mat X)
11    {
12    float a = X[1], b = X[2],
          x = X[3], y = X[4];
13    return a*y*sin(b*x);
14    }
```

*ONE of the following statements may be FALSE. Which one?*

a) F() is function of 4 variables.
b) Line 6 prints the gradient vector of F() at the point {Xo}.
c) Line 5: F(Xo) can be replaced by X[1]*X[4]*sin(X[3]*X[2]) without changing the computed values.
d) Line 8: DF is the total differential at Xo due to the changes {D}.
e) The program has no error(s).

---

f) None of the above.

```
13    return a*y*sin(b*x);
14    }
```

**16) Consider the following program that finds the minimum of F(m,t,w) with respect to t while m and W are fixed:**

```
1     main()
2     {
3     m = 0.15; W = 1000;
4     a = 0; b = 0.3;
5     to = root1(x, a, b,
           deriv(t,x,F(m, t, W)));
6     Fv = F(m,to,W);
7     D = deriv(x,to,
          deriv(t,x,F(m, t, W)));
8     print(^^,to,D,Fv);
9     clearplot();
10    plot(x,a,b, F(m,x,W));
11    }

12    F(float m, float t, float W)
13    {
14    return m*W/(m*sin(t)+cos(t));
15    }
```

*ONE of the following statements may be FALSE. Which one?*

a) The program has syntax error(s).

b) Line 5 finds t that solves $\frac{\partial F(m,t,W)}{\partial t} = 0$ .

c) Line 6: Fv is a local extremum of F().

d) Line 7: if D > 0, Fv is a local minimum.

e) Line 10 plots F(m,t,W) versus t.

f) None of the above.

17. The arc length of the curve $y = f(x)$ in the interval $a \le x \le b$ is given by the integral

$$L = \int_a^b \sqrt{1 + \left(\frac{df(x)}{dx}\right)^2}\, dx$$

The following program is supposed to compute the arc length of the curve $f(x) = \int_0^x \ln(\cos t)\, dt$ in $0 \le x \le \pi/3$.

```
1   main()
2   {
3       clearplot();
4       a = 0; b = pi#/3;
5       plot(t, a, b, f(t));
6       L = integ(x,a,b,sqrt(1+
                deriv(t,x,f(t))^2));
7   }

8   f(float x)
9   {
10      return integ(t,0,x,
                     ln(cos(t)));
```

*ONE of the following statements may be FALSE. Which one?*

a) The program has no syntax error(s).

b) The value of $\int_0^x \ln(\cos t)\, dt$ is independent of $t$, but is a function of $x$.

c) Function f(float x) returns $\int_0^x \ln(\cos t)\, dt$.

d) 't' in Line 10 can be replaced by any name other than 'x'.

e) Use of 't' in line 5 is proper.

f) Line 6 has error(s).

g) None of the above.

17. The arc length of the curve $y = f(x)$ in the interval $a \le x \le b$ is given by the integral

$$L = \int_a^b \sqrt{1 + \left(\frac{df(x)}{dx}\right)^2}\, dx$$

The following program is supposed to compute the arc length of the curve $f(x) = \int_0^x \ln(\cos t)\, dt$ in $0 \le x \le \pi/3$.

```
1   main()
2   {
3       clearplot();
4       a = 0; b = pi#/3;
5       plot(t, a, b, f(t));
6       L = integ(x,a,b,sqrt(1+
                deriv(t,x,f(t))^2));
7   }

8   f(float x)
9   {
10      return integ(t,0,x,
                    ln(cos(t)));
```

*ONE of the following statements may be FALSE. Which one?*

a) The program has no syntax error(s).

b) The value of $\int_0^x \ln(\cos t)\, dt$ is independent of $t$, but is a function of $x$.

c) Function f(float x) returns $\int_0^x \ln(\cos t)\, dt$.

d) 't' in Line 10 can be replaced by any name other than 'x'.

e) Use of 't' in line 5 is proper.

f) Line 6 has error(s).

g) None of the above.

18) Consider the following non-related expressions, each solving a math problem. They refer to an existing user-defined function F(float x, float y, float t) that returns the value of the function for any given x, y, t.

```
1.   r1 = root1(z,0,1,F(0,z,2)-0.2);
2.   r2 = root1(z,0,1,deriv(t,z,
           F(t,1,2))+ 2*z);
3.   r3 = root1(z, 0, 1,
           integ(t,0,z,F(1,2,t))-0.1);
4.   I1 = integ(x,0,2,
     integ(y,x^2,2*x,F(x,y,1)-x*y));
5.   r4 = root1(z,0,1,
     ((F(1,z+(Dz=1e-4)/2,2))
           -(F(1,z-Dz/2,2)))/Dz);
```

*ONE of the following statements may be FALSE. Which one?*

a) Line 1 solves $F(0,x,2) = 0.2$ for x.

b) Line 2 solves $\frac{\partial}{\partial x}F(x,1,2) = -2x$ for x.

c) Line 3 solves $\int_0^x F(1,2,u)du = 0.1$ for x.

d) Line 4 computes:
$\int_0^2 \int_{x^2}^{2x} [F(x,y,1) - xy]\, dydx$

e) Line 5 solves $\frac{\partial}{\partial x}F(1,x,2) = 0$ for x.

---

f) None of the above.

19) The following program is supposed to compute the definite integral $\int_a^b 2xe^{-0.12x^2} sinx\, dx$ by summing the areas of N rectangular strips under the curve.

```
1    main()
2    {
3    float a=0, b=4, N = 20, A;
4    A = Integ(a,b,N);
5    print(^^, N, A);
6    }

7    G(float x)
8    {
9    return 2*x*exp(-0.12*x^2)
         * sin(x);
10   }



11   Integ(float u,float v,float K)
12   {
13   float S=0,i,D=(v-u)/K,
         x = u + D/2;
14   for(i=1; i<=K; i=i+1)
15   {
16      S = G(x)* D;
17      x = x + D;
18   }
19   return S;
20   }
```

S = S + G(x)*D

*ONE of the following statements may be FALSE. Which one?*

a) The value of $\int_a^b 2xe^{-0.12x^2} sinx\, dx$ is independent of x

b) This program has no syntax error(s).

c) The computed integral generally gets better with larger 'N'.

d) Function G(. . .) is a proper implementation of the integrand.

e) At line 13: u = 0, v = 4, K = 20.

f) Function Integ() has no logical error(s).

---

g) None of the above.

ABSOLUTE VALUE OF x

20) The solution x of the equation f(x) = 0 may be found by the iterative formula:

$$x_2 = x_1 - \frac{f(x_1)}{\left.\frac{df(x)}{dx}\right|_{x=x_1}}$$

where $x_1$ is the initial estimate of the solution.

The following program is supposed to make use of the above formula to solve for the root of the equation $xe^{3x} - x^2 - 1 = 0$.

```
1    main()
2    {
3    Z = f(R = Solve(1));
4    print(^, R, Z);
5    }

6    Solve(float x1)
7    { // Newton-Raphson iteration
8    float Err, x2, D=0.001;
9    do {
10       x2 = x1-f(x1)/((f(x1+D/2)
                -f(x1-D/2))/D);
11       Err = x2-x1;
12       x1 = x2;
13       } while (Err > 0.00001);
14       return x2; // Root found
15   }

16   f(float x)
17   {
18   float K;
19   return x*exp(3*x)-x^2-1;
20   }
```

*ONE of the following statements may be FALSE. Which one?*

a) Line 4: 'R' is supposed to be the computed root, and 'Z' the residual.
b) Line 10 is an acceptable implantation of the iterative formula.
c) Line 12 sets the new solution estimates for the next iteration.
d) Function Solve() has no logical error(s).
e) Line 14: 'x1' can be returned instead of 'x2'.
f) Line 18 serves no purpose.

---

g) None of the above.