# FE TUTORING CLASS ON MATHEMATICS

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## Syllabus

| | | Chem | Civil | Elect & Computer | Mechanical | Environmental | Industrial | General |
|---|---|---|---|---|---|---|---|---|
| 1 | Analytic Geometry | x | x | x | x | x | x | |
| 2 | Roots of Equations | x | x | | | x | | |
| 3 | Calculus | x | x | x | x | x | x | x |
| 4 | Differential Equations | x | | x | x | x | | x |
| 5 | Vector Analysis | | x | x | x | | x | |
| 6 | Algebra and Trig | | | x | | | | x |
| 7 | Complex Numbers | | | x | | | | |
| 8 | Discrete Math | | | x | | | | |
| 9 | Linear Algebra | | | x | x | | x | x |
| 10 | Numerical Methods | x | | | x | x | | x |
| 11 | Matrix Operations | | | | | | x | |

**1. Analytical Geometry**

a) A straight line goes thru $(2, -3)$ and is perpendicular to $y = 5x - 13$. What is the equation of the line?

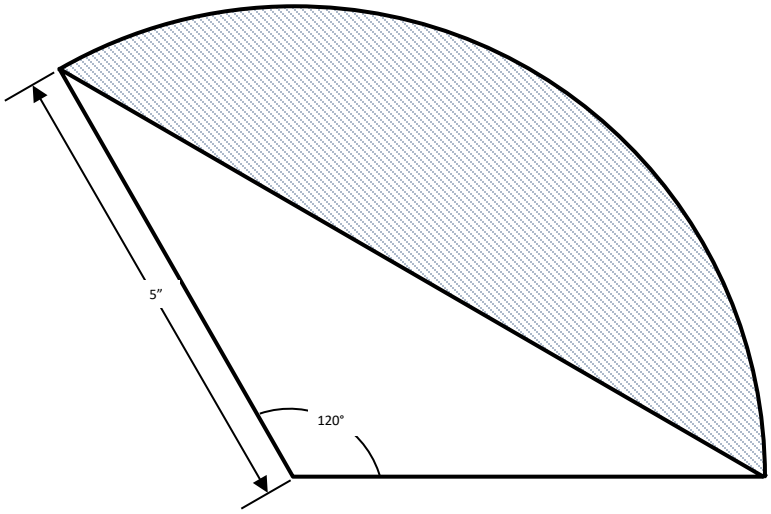
Answer: $y = -0.2x - 2.6$

b) Find the perimeter of an inscribed hexagon in a circle of diameter 1.

Answer: 3.0

c) What is the area of the portion of the circle shown as shaded? The side shown as 5" is the radius of the circle.

Answer: 15.35




d) Find the coordinates of the center and the radius of a circle if the equation of the circle given as

$$x^2 + y^2 - 2x - 8y - 19 = 0$$

.

Answer: Center coordinates are (1,4); Radius is 6.

Additional Note: Rather than a circle, another question may ask for center and radius of a sphere. It is the same except the equation of a sphere is $(x - a)^2 + (y - b)^2 + (z - c)^2 = R^2$

**2. Roots of Equation**

a) The velocity of the body is given as

$$v(t) = 5e^{-t} + 4$$

.

When is the velocity $6m/s$?

Answer: $0.9163$

b) Find the roots of the quadratic equation

$$3\mathrm{x}^2 + 7\mathrm{x} + 9 = 0$$

Answer: $-1.1667 + 1.2802j, -1.1667 - 1.2802j$

c) Under what circumstances are the roots of a quadratic equation

$$ax^2 + bx + c = 0$$

complex?

Answer: $b^2 - 4ac$<0

**3. Calculus**

a) Write the definition of $f'(x)$

Answer: $f'(x) = \lim_{\Delta x \to 0} \frac{f(x+\Delta x)-f(x)}{\Delta x}$

b) Given the distance, $S$ covered as a function of time, $t$ is

$$S = 20t^3\text{-}t^4,$$

find the acceleration at $t = 2$.

Answer: 192

c) What is the maximum value of

$$y = 2x^3 + 12x^2\text{-}30x + 10$$

in the domain of $x = [-10,10]$.

Answer: 2910

d) Find

$$\int_0^{\pi} 10 \sin 2x \, dx$$

Answer: 0

e) What is the approximate area bounded by

$y = 8 - x^2$ and $y = -2 + x^2$?

Answer: 29.8

f) Find

$$\int_{0.2}^{2.2} xe^x dx$$

Answer: 11.807.

g) If

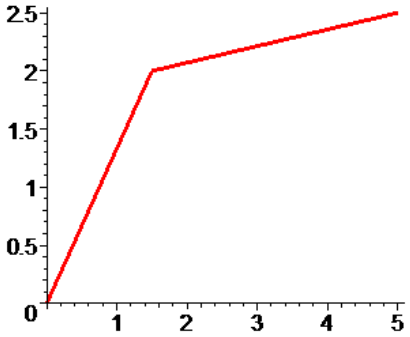
$$u(x,y,z) = 2x^2 + 3y + 5\sin z$$
$$v(x,y,z) = 5x^3 + 4y^2 + 10xz$$
$$w(x,y,z) = \frac{4}{x^2} - 7\tan z \ + 10x^2z$$

then find

$$\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}$$

Answer: $3 + 15x^2 + 10z$

h) Find the integral $\int_0^5 f(x)dx$




Answer: 9.375

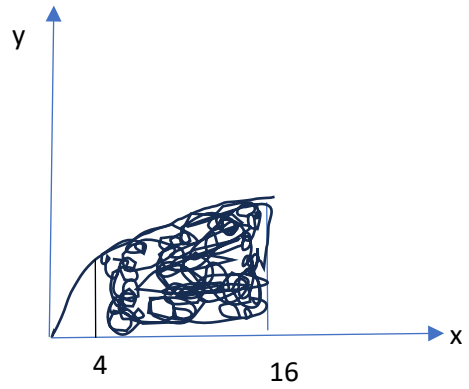
i) Find the following limit

$$\lim_{x \to 0} \frac{\sin 3x}{2x}$$

Answer: 1.5

j) Find the radius of curvature of the function $f(x)$ at point $(x, y) = (5,2)$ where $f(x) = 2x^2 + 6x - 78$.
Answer: 4404

k) What is the area of the shaded portion of the figure below if the curve drawn is $y = \sqrt{x}$




Answer: 37.33

**4. Differential Equations**

a) What is the general solution to

$$(D+2)^2 y = 0$$

Answer: $y = A_1 e^{-2x} + A_2 x e^{-2x}$

b) Solve

$$\frac{dy}{dx} + 5y = 0, y(0) = 1$$

.

Answer: $y = e^{-5x}$

c) Find the form of the particular part of the solution for

$$\frac{\mathrm{d}^2\mathrm{y}}{\mathrm{dx}^2} - 4\frac{\mathrm{dy}}{\mathrm{dx}} + 4\mathrm{y} = \mathrm{e}^{2\mathrm{x}} + \sin \mathrm{x}, \qquad \mathrm{y}(0) = 5, \frac{\mathrm{dy}}{\mathrm{dx}}(0) = 6.$$

Answer: $y_p = Ax^2 e^{2x} + B \sin x + C \cos x$

d) Use Euler's method to solve for $\mathrm{y}(5)$ given

$$\frac{dy}{dx} + 2y = x^2, y(1) = 5$$

Use a step size of $h$=2.

Answer: 57

e) Find the inverse Laplace transform of

$$L(s) = \frac{s(s+12)}{(s+6)(s+15)}$$

.

Answer: $\delta(t) - 4e^{-6t} - 5e^{-15t}$

f) What is the Laplace transform of $4\,sin(\,t)\,cos(\,t)$

Answer: $L(s) = \frac{4}{s^2+4}$

**5. Vector Analysis**

a) Find the cross product of

$$\vec{A} = 3i + 5j + 7k$$
$$\vec{B} = 11i + 13j + 17k$$

Answer: $-6i + 26j - 16k$

Additional Note: This is also the vector perpendicular to plane determined by $\vec{A} = 3i + 5j + 7k$ and $\vec{B} = 11i + 13j + 17k$. They may ask you find the **unit** vector perpendicular to plane determined by $\vec{A} = 3i + 5j + 7k$ and $\vec{B} = 11i + 13j + 17k$. Then the answer is $(-6i + 26j - 16k)/\sqrt{(-6)^2 + 26^2 + (-16)^2}$

b) Find the dot product of

$$\vec{A} = 3i + 5j + 7k$$
$$\vec{B} = 11i + 13j + 17k$$

Answer: $217$

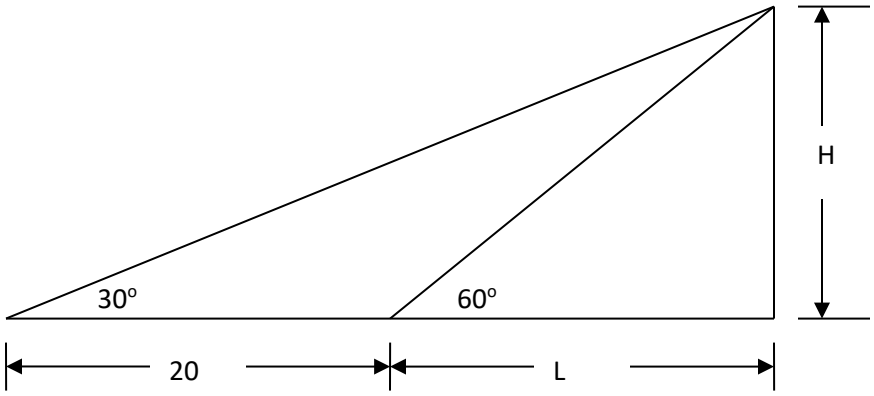
c) Find the angle in degrees between the two vectors

$$\vec{A} = 3i + 5j + 7k$$
$$\vec{B} = 11i + 13k + 17k$$

Answer: $8.124°$

**6. Algebra and Trigonometry**

a) Find the value of H.




Answer: 17.32

**7. Complex Numbers**

a) Simplify the following rational form of the complex number.

$$\frac{5 + 6.2j}{6 + 8j}$$

Answer: $0.796 - 0.028j$

b) Write the complex number $7 + 3j$ in polar form.

Answer: $7.616e^{0.4049j}$

c) Find the complex conjugate of $7 + 3j$.

Answer: $7 - 3j$

**8. Discrete Math**
XXXXXX

**9. Linear Algebra**
a) Find the determinant of

$$\begin{bmatrix} 2 & 6 & 7 \\ 4 & 3 & 8 \\ 8 & 6 & 6 \end{bmatrix}$$

Answer: 180

b) Find the inverse of

$$\begin{bmatrix} 2 & 5 \\ 4 & 13 \end{bmatrix}$$

Answer: $\begin{bmatrix} 2.1667 & -0.8333 \\ -0.6667 & 0.3333 \end{bmatrix}$

c) Find the unit vector corresponding to the vector

$$3i + 4j + 7k$$

.
Answer: $0.3488i + 0.4650j + 0.8138k$

**10. Numerical methods**
a) Find the root of

$$x^2 = 5$$

after two iterations of Newton-Raphson method. Assume initial guess of $x_0 = 3$.
Answer: 2.2381

**11. Matrix Operations**
a) Find

$$\begin{bmatrix} 2 & 5 & 6 \\ 7 & 8 & 8 \end{bmatrix} \begin{bmatrix} 3 & 1 \\ 6 & 2 \\ 9 & 5 \end{bmatrix}$$

Answer: $\begin{bmatrix} 90 & 42 \\ 141 & 63 \end{bmatrix}$

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