FE Exam Preparation - Mathematics

General Advice(?): Get the calculator that you are going to use (you might consider a TI-36X Pro, which can compute definite integrals) and the Reference Handbook well ahead of time and get used to working with both. Maybe use the calculator to do some of your classwork, just to become familiar with where the various operations and functions are. **Be aware of this**: Due to the fact that the exam is multiple choice, with answers provided, *I would suggest that you not "completely" solve any exercise unless it is absolutely necessary.* Here are some ways to solve problems without actually working them out completely:

- When appropriate, draw a fairly accurate picture and estimate; the scales on pictures provided with the exercises seem to be very accurate, so that estimates can be made from the pictures.
- When you are asked to solve an algebraic equation or system of equations, you can check the solutions that are provided, rather than actually solving the equation(s).
- To determine whether two trig expressions are equivalent, just substitute an angle into both and see if they come out the same. DO NOT substitute special angles like $30°$, $45°$, $60°$, etc. - use something like $20°$ instead.
- When working a problem that contains an angle whose measure is in degrees and minutes, just round to the nearest whole degree - the choices of answers will vary enough that you can determine the correct answer from your slightly incorrect answer.
- When in doubt, have your calculator in radians unless working a problem with angles given in degrees.

Here are some mathematical facts that I found useful when working the exam problems:

- If $\frac{a}{b} = \frac{c}{d}$, then $\frac{b}{a} = \frac{d}{c}$.
- $\frac{a \pm b}{c} = \frac{a}{c} \pm \frac{b}{c}$, and the same sort of thing holds when the numerator has more terms.

Solutions to Equations and Systems of Equations

- If potential solutions are given, try substituting them into the given equation(s) to see which one(s) they satisfy.
- When asked which expression is equivalent to a given one, substitute a value into the given one, and the same value into the possible equivalents. When you get the same value from two expressions, those should be the ones that are equal.
- When evaluating equations with trig functions *and* non-trig functions, your calculator must be in radians.

Analytic Geometry

- When the equation of a line is put in the form $y = mx + b$, m is the slope of the line and b is the y-intercept. Parallel lines have the same slope and perpendicular lines have slopes that are negative reciprocals, like $\frac{3}{2}$ and $-\frac{2}{3}$.
- To plot a polar coordinate point (r, θ), rotate counterclockwise by θ **from the positive x-axis**, then go out from the origin by r units.

- Equations of the form $ax^2 \pm by^2 + cx + dy + e = 0$ are for
  - a circle if $a = b$ and the first sign is $+$ **Example:** $x^2 + y^2 + 3x - 8y + 12 = 0$
  - an ellipse if $a \neq b$ and the first sign is $+$ **Example:** $4x^2 + y^2 + 3x - 8y + 12 = 0$
  - a hyperbola if the first sign is $-$ **Example:** $x^2 - 2y^2 + 3x - 8y + 12 = 0$

Vectors and Matrices

- The length (magnitude, norm) of a vector is its length, obtained by adding the sums of its components and taking the square root.
- A **unit vector** is a vector of length one. None of the individual components of a unit can be more than one in absolute value.
- The dot product of two vectors is a scalar, and it is zero if the vectors are perpendicular.
- The cross product of two vectors is a vector, and *it is perpendicular to both of the original vectors.*
- All properties of arithmetic that hold for numbers also hold for matrices, except that *matrix multiplication is NOT commutative.* That is, for two matrices $\mathbf{A}$ and $\mathbf{B}$ it is not necessarily true that $\mathbf{AB} = \mathbf{BA}$. (It can be true for particular choices of $\mathbf{A}$ and $\mathbf{B}$, but usually isn't.)

Calculus

- Evaluate limits numerically, using your calculator. For example, to evaluate $\lim_{x \to 0} \dfrac{\sin(3x)}{e^{2x} - 1}$, "plug in" something like 0.001 for x and see what you get.
- The gradient of a function $f(x, y)$ of two variables is the vector

$$\nabla f(x, y) = \frac{\partial f}{\partial x}\mathbf{i} + \frac{\partial f}{\partial y}\mathbf{i}$$

  When evaluated at a point (x, y) it gives the direction one can go from that point to experience the greatest rate of increase of the function. The rate of increase in that direction is the magnitude (length) of that vector.

Quickies: These are questions in my edition of the *FE Review Manual* (so they may not match the newer edition) that can be answered fairly quickly using a picture, your calculator, the reference manual or very little paper-and-pencil calculation. Give yourself about 30 seconds to a minute on each. The method for doing each is shown in another document.

Geo/Trig Sample Problems: 1,5

Geo/Trig Exam Problems: 1,2,3,6, 8-12,14,16,17

Algebra Sample Problems: 1,2,5

Algebra Exam Problems: 1,2,6-9,12-16,20,29,30

Prob/Stat Exam Problems: 10-12

Calculus Sample Problems: 1,4,5

Calculus Exam Problems: 1,3,4,5,6,12,19-21