Disclaimer: This Final Exam Study Guide is meant to help you start studying.
It is not necessarily a complete list of everything you need to know.

The MTH 234 final exam mainly consists of standard response questions where students must justify their work. In addition to these, the Final Exam may consist of: fill in the blank, true/false, or multiple choice questions.

Most instructors agree that a good way to study for the final is to do lots of problems to help familiarize yourself with all of the concepts covered.

Sections containing similar concepts have been grouped in blue boxes. Most MTH 234 final exam writers agree that the items below contain crucial material for showcasing MTH 234 knowledge and are therefore **very important**. Expect at least one problem from each group on the final exam.

Important Items from Each Section:

12.3 - The Dot Product

- Recall that $\mathbf{a} \cdot \mathbf{b} = |\mathbf{a}|\,|\mathbf{b}| \cos\theta$ and use this to solve for angles between vectors.
- Remember the projection of $\mathbf{b}$ onto $\mathbf{a}$ formula: $\text{proj}_{\mathbf{a}}\mathbf{b} = \frac{\mathbf{a}\cdot\mathbf{b}}{|\mathbf{a}|^2}\mathbf{a}$.

12.4 - The Cross Product

- Know how to calculate $\mathbf{a} \times \mathbf{b}$ using the determinate.

12.5 - Equations of Lines and Planes

- Remember how to parametrize straight lines: $\mathbf{r} = \mathbf{r}_0 + t\mathbf{v}$.
- Recall the equation of a plane: $a(x - x_0) + b(y - y_0) + c(z - z_0) = 0$.
- Be able to calculate the angle between two planes.
- Determine the distance between combinations of points, lines, and planes.
- Study this section well. There are many types of problems here.

Good Final Exam Review Problems:

- 12.3.17
- 12.3.43
- 12.4.4
- 12.4.27
- 12.4.44
- 12.5.5
- 12.5.9
- 12.5.33
- 12.5.38
- 12.5.45
- 12.5.64
- 12.5.69
- 12.5.71
- 12.5.73
- 12.5.78

Important Items from Each Section:

13.2 - Derivatives and Integrals of Vector Functions

- Recall that $\mathbf{r}'(t)$ is the tangent vector to $\mathbf{r}(t)$.
- Be able to derive and integrate vector valued functions.

13.3 - Arc Length and Curvature

- Know the arc length formula: $L = \int_a^b |\mathbf{r}'(t)|\, dt$

Good Final Exam Review Problems:

- 13.2.26
- 13.3.2
- 13.4.4
- 13.3.1
- 13.3.15
- 13.4.18a

Important Items from Each Section:

14.4 - Tangent Planes and Linear Approximations

- Recall the formula for the tangent plane.
- Be able to calculate the linearization, $L(x, y)$ and use it to estimate the value of a function.

14.6 - Directional Derivatives and the Gradient Vector

- Be able to calculate the directional derivative using the dot product.
- Know how to maximize and minimize the directional derivative.
- Determine equations of tangent planes to level surfaces.

Good Final Exam Review Problems:

- 14.4.4
- 14.6.7
- 14.6.25
- 14.4.21
- 14.6.12
- 14.6.44

Important Items from Each Section:

14.5 - The Chain Rule

- Recall the Chain Rule: $\frac{dz}{dt} = \frac{\partial z}{\partial x}\frac{dx}{dt} + \frac{\partial z}{\partial y}\frac{dy}{dt}$
- Know the Implicit Function Theorem which gives us:

$$\frac{dy}{dx} = -\frac{F_x}{F_y}.$$

Good Final Exam Review Problems:

- 14.5.2
- 14.5.23
- 14.5.30

Important Items from Each Section:

14.7 - Maximum and Minimum Values

- Know how to find critical points.
- Be able to classify critical points using the Second Derivatives Test.
- Recall how to find absolute Maximums and Minimums on closed bounded regions.

Good Final Exam Review Problems:

- 14.7.9
- 14.7.14
- 14.7.30
- 14.7.32
- 14.7.41
- 14.7.43

Important Items from Each Section:

15.6 - Surface Area

- Know the surface area formula: $A(s) = \iint_D \sqrt{1 + \left(\frac{\partial z}{\partial x}\right)^2 + \left(\frac{\partial z}{\partial y}\right)^2}\, dA$

15.7 - Triple Integrals

- Know how to sketch regions of integration.
- Be able to determine how/when to switch the order of integration.
- Double Integrals over General Regions (see 15.3), is an easier version of this.

15.8 - Triple Integrals in Cylindrical Coordinates

- Recall how to switch from rectangular to cylindrical coordinates:
  - $x^2 + y^2 = r^2$
  - $x = r\cos\theta$
  - $y = r\sin\theta$
  - $y/x = \tan\theta$
  - $\iiint_E f(x, y, z)\ dV = \iiint_E f(r\cos\theta, r\sin\theta, z)\ r\ dz\ dr\ d\theta$
- Double Integrals in Polar Coordinates (see 15.4), is an easier version of this.

15.9 - Triple Integrals in Spherical Coordinates

- Recall how to switch from rectangular to spherical coordinates:
  - $x^2 + y^2 + z^2 = \rho^2$
  - $x = \rho\sin\phi\cos\theta$
  - $y = \rho\sin\phi\sin\theta$
  - $z = \rho\cos\phi$
  - $\iiint_E f(x, y, z)\ dV = \iiint_E f(\rho\sin\phi\cos\theta, \rho\sin\phi\sin\theta, \rho\cos\phi)\rho^2\sin\phi\ d\rho\ d\phi\ d\theta$

Good Final Exam Review Problems:

- 15.3.51
- 15.4.13
- 15.6.4
- 15.6.12
- 15.7.13
- 15.7.20
- 15.8.18
- 15.8.21
- 15.8.24
- 15.9.24
- 15.9.28
- 15.9.39

Important Items from Each Section:

16.2 - Line Integrals

- Know how to evaluate line integrals over scalar functions using:

$$\int_C f(x,y)ds = \int_a^b f(x(t),y(t))\sqrt{\left(\frac{dx}{dt}\right)^2+\left(\frac{dy}{dt}\right)^2}\,dt$$

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- Know how to evaluate line integrals over vector fields using: $\int_C \mathbf{F}\cdot\mathbf{T}ds = \int_a^b \mathbf{F}(\mathbf{r}(t))\cdot\mathbf{r}'(t)\,dt$.

16.4 - Green's Theorem

- Know when to apply Green's Theorem: $\int_C P\,dx + Q\,dy = \iint_D \left(\frac{\partial Q}{\partial x} - \frac{\partial P}{\partial y}\right)dA$.

16.5 - Curl and Divergence

- Know the normal form of Green's Theorem: $\int_C \mathbf{F}\cdot\mathbf{n}\,ds = \int_C P\,dy - Q\,dx = \iint_D \left(\frac{\partial P}{\partial x} + \frac{\partial Q}{\partial y}\right)dA$.
- Be able to evaluate line integrals with respect to the normal component of $\mathbf{F}$.

Good Final Exam Review Problems:

- 16.2.2
- 16.2.10
- 16.4.8
- 16.2.7
- 16.4.4
- 16.4.18

Important Items from Each Section:

16.3 - The Fundamental Theorem for Line Integrals

- Recall the component test for conservative vector fields: $\frac{\partial P}{\partial y} = \frac{\partial Q}{\partial x}$.
- If $\mathbf{F}$ is conservative know how to find a function f such that $\nabla f = \mathbf{F}$.
- Be able to use the fundamental theorem of line integrals: $\int_C \nabla f\cdot d\mathbf{r} = f(\mathbf{r}(b)) - f(\mathbf{r}(a))$.

16.5 - Curl and Divergence

- Recall the component test for conservative vector fields on $\mathbb{R}^3$: $\nabla\times\mathbf{F} = 0$.

Good Final Exam Review Problems:

- 16.3.6
- 16.3.20
- 16.5.16
- 16.3.15
- 16.5.13
- 16.5.18

Important Items from Each Section:

16.5 - Curl and Divergence

- Recall the formulas for curl $\mathbf{F} = \nabla \times \mathbf{F}$ and div $\mathbf{F} = \nabla \cdot \mathbf{F}$.

16.6 - Parametric Surfaces and Their Areas

- Know how to parametrize and sketch a variety of surfaces.
- Remember the formula for surface area: $A(S) = \iint_D |\mathbf{r}_u \times \mathbf{r}_v| \, dA$
- Recall that if your surface is of the form $z = f(x, y)$, then you can use $A(S) = \iint_D \sqrt{1 + \left(\frac{\partial z}{\partial x}\right)^2 + \left(\frac{\partial z}{\partial y}\right)^2} \, dA$ for surface area.

16.7 - Surface Integrals

- Be able to calculate various surface integrals using the equations:
  - $\iint_S f(x, y, z) dS = \iint_D f(\mathbf{r}(u, v)) \, |\mathbf{r}_u \times \mathbf{r}_v| \, dA$
  - $\iint_S f(x, y, z) dS = \iint_D f(x, y, g(x, y)) \sqrt{1 + \left(\frac{\partial z}{\partial x}\right)^2 + \left(\frac{\partial z}{\partial y}\right)^2} \, dA$

  when appropriate.
- Know how to calculate the flux integral: $\iint \mathbf{F} \cdot d\mathbf{S} = \iint_S \mathbf{F} \cdot \mathbf{n} \, dS$
- Recall the formulas:
  - $\iint_S \mathbf{F} \cdot d\mathbf{S} = \iint_D \mathbf{F} \cdot (\mathbf{r}_u \times \mathbf{r}_v) dA$
  - $\iint_S \mathbf{F} \cdot d\mathbf{S} = \iint_D \left(-P \frac{\partial g}{\partial x} - Q \frac{\partial g}{\partial y} - R\right) dA$

  and know when is the appropriate time to use each.

16.8 - Stokes' Theorem

- Recall Stokes' Theorem: $\int_C \mathbf{F} \cdot d\mathbf{r} = \iint_S \text{curl } \mathbf{F} \cdot d\mathbf{S}$ and know how/when to use it.

16.9 - The Divergence Theorem

- Recall the Divergence Theorem: $\iint_S \mathbf{F} \cdot \mathbf{n} \, dS = \iiint_E \text{div } \mathbf{F} \, dV$ and know how/when to use it.

Good Final Exam Review Problems:

- 16.6.3
- 16.6.24
- 16.7.6
- 16.7.9
- 16.7.26
- 16.8.2
- 16.8.6
- 16.8.8
- 16.8.10
- 16.9.6
- 16.9.8
- 16.9.17

Most MTH 234 final exam writers agree that the items below contain material that is also **important**. However the appearance of problems below tend to fluctuate more from semester to semester. Students wishing to do well on the final should be familiar with this material as well.

Important Items from Each Section:

14.1 - Functions of Several Variables

- Be able to determine the domain and range of a function.
- Know to sketch a function.
- Recall how to find level curves.

Good Final Exam Review Problems:

- 14.1.13
- 14.1.30
- 14.1.51

Important Items from Each Section:

14.2 - Limits and Continuity

- Determine when simple limits exist (usually through algebraic manipulation).
- Use the 2 path test to show that a limit does not exist.
- Be able to use the definition of continuity to show when functions are or are not continuous.

Good Final Exam Review Problems:

- 14.2.14
- 14.2.18
- 14.2.38