MA205 – Sections A53, C53, and D53

TEE, Study Checklist

Mathematica related items are marked with an *.

Block I: Integration in 1-variable

I. Estimating Area Under the Curve

*___ I know how to estimate the area under a curve using the midpoint, trapezoidal, left endpoint, and right endpoint rules (by hand and in Mathematica with my own template)

___ I know that the accuracy increases as I increase the number of rectangles

___ I know that if I take the limit of the sum as the number of rectangles goes to infinity, then I will get the EXACT area under the curve, and I can write that as an integral.

II. Fundamental Theorem of Calculus & Net Change Theorem

___ I understand the fundamental theorem of calculus (antiderivatives = integrals)

___ I understand the net change theorem (integral of a rate of change = amount of change, like velocity and distance)

III. Indefinite Integrals and Definite Integrals

___ I know how to find a definite integral, F(b)-F(a)

___ I know how to find an indefinite integral, F(x)+C

*___ I know how to solve definite and indefinite integrals in Mathematica

IV. U-substitution

___ I know how to do u-substitution

V. Parametric Equations and Vector Equations

___ I understand how to convert between Cartesian equations and parametric equations

*___ I know how to plot a parametric curve in Mathematica

___ I understand how I can use vector functions to represent a path through 2D or 3D space

VI. Applications

A. Work (lifting ropes/chains and pumping water)

___ I understand how to break a work problem into slices and calculate the work for a slice

___ I understand how to use summation notation to represent the total work

___ I know how to convert from summation notation to integral notation and how to set up my bounds such that I can solve the work problem

___ I understand how to use units!

B. 2D arc-length

___ I know the formula for 2D arc-length (integral = summation of tiny distances!), or at least I know exactly where it is on my allowed 8.5”x11” HANDWRITTEN paper

*___ I have a template that I understand for solving 2D arc-length in Mathematica with y[x], and I will NOT confuse it with my 3D arc-length template!

C. 3D arc-length

___ I know the formula for 3D arc-length, or at least I know exactly where it is on my allowed 8.5”x11” HANDWRITTEN paper

*___ I have a template that I understand for solving 3D arc-length in Mathematica with x[t], y[t], and z[t], and I will NOT confuse it with my 2D arc-length template!

D. Motion in Space

___ I understand the relationship between displacement (position), velocity, and acceleration (derivatives and antiderivatives)

___ I understand how to use vector equations to represent motion in space

___ I understand projectile motion, and I know the vector equations that describe projectile motion and how to derive them

Block II: Multi-variable integration

I. Estimating Volume Under the Surface

___ I understand how to estimate the volume under a surface using sample points (midpoint, upper left, etc.)

___ I understand that as I increase the number of sample regions, the accuracy of my volume estimate increases

___ I understand that in limit (infinite number of regions), I get an exact answer for volume and this is the same as taking the double integral

II. Rectangular Regions (Fubini: $dy\,dx = dx\,dy$)

___ I know how to perform an iterated integral (treat one variable as a constant when anti-differentiating with respect to the other variable), and I understand the importance of matching the bounds with the order of integration (inside integral first, then outside integral)

III. General Regions ($dy\,dx$ vs $dx\,dy$ – remember Scoopy and the driveway snow!)

___ I know how to sketch a region in the xy-plane and determine if it is Type I, Type II, either, or neither

___ I know how to set up the bounds of integration for the double integral for a general region

IV. Polar regions ($dy\,dx = r\,dr\,d\theta$)

___ I understand that some problems are geometrically circular, and so polar coordinates will be easier

___ I know how to convert between x, y, r, and θ

___ I know that $dy\,dx = r\,dr\,d\theta$

___ I know how to draw a polar region in the xy-plane and how to set up the bounds of integration for a polar double integral

V. Application: Center of Mass

___ I know the equations to find the center of mass of a lamina

Block III: Differential Equations

___ I know how to classify differential equations (order, linearity, homogeneity).

___ I understand the difference between a differential equation and its solution!!!

I. First Order

A. ___ I know how to use Separation of Variables to solve DEs.

B. *___ I know how to use Euler's Method (by hand and w/ Mathematica) to solve DEs.

C. *___ I know how to plot slope fields in Mathematica, draw particular solutions by hand, identify long term behavior, and identify equilibrium solutions.

D. *___ I know how to use DSolve in Mathematica.

E. ___ I know how to set up the differential equation for a single tank mixing problem, and I can use one of the methods above to solve for a solution (general or, if given initial conditions, particular).

F. ___ I know how to model population growth (exponential, logistic, harvesting) using differential equations, and I can use one of the methods above to solve for a solution (general or, if given initial conditions, particular).

G. ___ I know how to model heating and cooling using Newton's Law of Cooling, and I can use one of the methods above to solve for a solution (general or, if given initial conditions, particular).

II. Second Order

A. ___ I know how to find a characteristic equation.

B. ___ I know how to solve a characteristic equation.

C. ___ I know how to select which Case I have (I, II, or III), and I can write the general form of the solution accordingly.

D. ___ If given initial conditions, I know how to use those (y(0) and y'(0)) to solve for my constants, c_1 and c_2, such that I can find the particular solution.

E. ___ I know how to model the motion of a spring/mass system using differential equations.

F. ___ I know how to find the solution to the characteristic equation and how to use c^2-4mk to classify the damping as over-damped, critically damped, or under-damped.

G. ___ I know how to write the general form of the solution for any of the three damping cases.

H. ___ I know how to identify initial conditions (initial position and initial velocity), and using these, I know how to solve for the particular solution.

I. *___ I know how to use DSolve and initial conditions to solve for the particular solution.

III. Systems of DEs

A. ___ I know how to model a multi-tank mixing problem using a system of differential equations.

B. ___ I know how to write a homogeneous system of differential equations in matrix form.

C. *___ I know how to use the Eigensystem command in Mathematica to get my eigenvalues and eigenvectors.

D. ___ I know how to write the general form of a solution to a system of differential equations.