List of topics and problems for the First midterm. The following is a list of topics that are included in the first midterm. We also include the problems from the practice section corresponding to each section. The exam questions will be at the level of the homework and the practice problems.

(1) Chapter 3
   (a) Differentiation and integration of vector functions. Know how to integrate and differentiate them (you also need to know the basics of vectors: how to add and multiply them by scalars, length, dot product, cross product, etc). Know what velocity, speed and acceleration are. You won’t be tested specifically on this, but it will probably show up as part of another problems. This is on 13.1. Practice problem #3,4,8,30,31 and similar.
   (b) Arc-length. Know the formula for arc-length and how to find the arc-length parameter. Know also how to calculate the tangent line to a vector function. Type of problem 1-14 in page 935. Practice problem: # 21,22,31,33 and similar.
   (c) The Frenet moving frame: Tangent, normal and binormal. Also curvature and torsion. Learn them together: learn what the tangent is, how to find the curvature and then calculate the normal. Once you have the normal, you can find the binormal and then the torsion. this is 13.3, 4 and 5 together. You also need to know the 2D version that has only $T$ and $N$, together with the curvature. Practice problems: #5,6,23,24,25,26,29 and similar.
   (d) Learn how to deduce the formula that expresses the acceleration as a sum of a tangential component and a normal component. I can ask explicitly for the deduction of the formula, and then ask you to apply it as in practice problems #27,28 and similar.
   (e) Learn what the osculating circle, radius of curvature and center of curvature are. Learn also what osculating, normal and rectifying planes are, and how to find them. As in practice #32 and similar.

(2) Chapter 4
   (a) Learn well the difference between a level set, defined by $F(x, y, z) = 0$ in 3D or by $F(x, y) = 0$ in 2D, and a graph defined by $z = f(x, y)$ in 3D. Many mistakes come from confusing these two in problems. Know the basic surfaces: sphere, ellipsoid, paraboloid and hyperboloid.
   (b) Learn how to find simple limits (those that can be found either directly or through some algebraic manipulation) and how to show that a limit does not exist using different paths to approach the limit. This can be asked in the context of continuity (is the following function continuous at... that type of problem). As in practice problems #9-17.
   (c) Partial derivatives. Learn the geometric interpretation and how to find them. I could ask you to find the slope of a certain line, and you will need to know which partial derivative it corresponds to. Also double and higher order partials. As in practice problems #19-28.
   (d) Know the definition of a differentiable function. I can ask for it.
   (e) Chain rule: what can I say... you will get a number of these, you just have to get good at it. It can be with two or three or more variables, through implicit differentiation or applied in some context. It also shows up in the last section when you need to decide which coordinates are dependent or independent. It is all over the place. Some practice is in #29-34.
   (f) Directional derivatives, gradient and the relation between these two. Know the different directions where a function increases and decreases the fastest, and where there is no change. Do not confuse this part with the normal direction to a level set, which is also given by the gradient of the function defining the level set. As in practice problems #37-43.
   (g) Know how to find tangent planes and normal lines. Also how to find the linearization of a function and to estimate the error when we use the tangent plane to approximate the value of a function. Use the total differential to determine the sensitivity to change of a function as its variables change. As in practice problems #47-54, 55-58 and 59-61.
   (h) Local Max, min and saddle points: how to find them and how to use the second derivative test. As in #65-70.
(i) Absolute Max and Min in a closed region. Know how to find them (find the local ones, the ones along the boundary and compare them). As in #71-78.
(j) Lagrange multipliers. You will get one in the exam! Either with one or two multipliers, as in problems #79-88.
(k) Section 14.9 is essentially the chain rule but you also have to determine which are the dependent and independent variable (and show that you can make that choice). #89-90.