Mathematics Examination Feedback Form

This form is intended to provide generic feedback to students on examination performance in individual units, in line with university code of practice for the assessment of taught programmes. Its purpose is to help students to develop their skills, knowledge and understanding and help them evaluate their current level of performance.

Unit Title:	Ordinary Differential Equations 2
Unit Code:	MATH--20101J
Examination Markers:	Stephen Wiggins

Common areas that were well done:
Q1: a) Most students were able to directly compute the flow by integrating the equations. b) Students were easily able to determine that the vector field had no periodic orbits; either directly from the flow, or from an application of Bendixon's criterion. c), d) Most students were able to compute the stable manifold of the origin and the centre manifold of the origin. **Q2:** Most students understood how to correctly apply the concept of invariance to identify the stable and center manifolds of the origin (b) and c)). They were then able to recognize that the vector field restricted to the centre manifold was a problem already analysed in class. **Q3:** Most students understood that this was a problem related to the bifurcation of periodic orbits, i.e. Hopf bifurcation. Most students were able to correctly transform the vector field to polar coordinates. They were then able to recognize that the r component of the vector field was a form that was previously treated in class in a different context that could be applied to this problem. Most students had no problem with the "new" concept of a saddle-node bifurcation of periodic orbits. **Q4:** Most students did well with this question. It was similar to ones seen in class, the set, problems, and previous year exams. The only slight difference was that the vector field was defined by a trigonometric function, rather than a polynomial. However, most students had no problem with this.

Common errors, misunderstandings or other areas requiring improvement:

Q1: a) A few students had difficulty integrating the exponential function with proper limits in order to obtain the flow. b) A few students had difficulty understanding the requirements that define the stable manifold directly from the flow (even though a very similar example was discussed in class).

Q2: Some students tried the compute the center manifold using a power series expansion, rather than realizing that invariance could be used resulting in no required computations.

Q3: Some students did not realize that for polar coordinates r could not be negative. This caused some confusion with the describing the types of bifurcations that could occur.

Q3: Some students were not able to apply the domain of the trigonometric function given in the problem to the structure of the vector field. Some students appeared to have difficulty with the definition of "nonhyperbolic fixed point".

General comments on the paper:

Overall, the students did very well on this exam. There were some points on the exam that were slightly different than what was discussed in class (e.g. saddle-node bifurcation of periodic orbits), but these appeared to pose know difficulties to students that understood the fundamental concepts.