Math 310 – Homework #11 Cover Sheet **name**:

- tutorial, check one: ◯ T9:30; ◯ T10:30; ◯ T11:30; ◯ R10:30; ◯ R11:30; ◯ R12:30.

- begin each problem on a new page & clearly identify each question.
- use words to describe your procedures & to interpret your results.
- put $\boxed{\text{boxes}}$ around your final results.
- due on friday 29 november at START of lecture.

question #	CONCEPT keywords & MAIN formula/result
#9.2.21/22	concept
	result
# 9.3.9	
# 9.4.6	

- problems for submission are indicated in **bold**.
- homework portfolios will also be graded on completeness & presentation (clarity & conciseness).

Section 9.1

- practice: this section should be very reminiscent of section 7.5.

Section 9.2

- essential idea: even though one cannot find $x(t), y(t)$ explicitly, one can sometimes find the graph (x, y) of the phase plane trajectories.
- practice: # 10-14, especially parts a) & c).

#21/22 do only part a). Then modify the matlab ODE solver *code10Fd.m* (from 08 November) to solve #21 and verify numerically that the graph of the function $H(x(t), y(t))$ is indeed a constant in t for any solution. You need only to produce one plot that shows $x(t), y(t)$ and $H(x(t), y(t))$ as functions of time for one initial value.

Matlab tip: in the script, $y(:,1)$ and $y(:,2)$ are column vectors holding the numerical solutions $x(t_j)$ and $y(t_j)$ at times t_j as output in the column vector t. You can easily do the arithmetic of column vectors by using ".$*$" and ".$\wedge 2$" which act elementwise on vectors.

Section 9.3

- be sure to understand the table 9.3.1 in terms of the stability. The type refers to the phase plane plots in sections 9.1 and 9.2.
- practice: # 5-7 (a,b,c)

#9 parts a), b), c) only. Organize your work in a clear format.

Section 9.4

- practice: # 1-2

#6 do parts a), b), c); produce hand sketches for d); e) is optional; but take part f) seriously. In particular, this problem is a model for an effect known as *mutual symbiosis* – compare the stable steady-state you find to the logistic steady-state if both xy-terms in the ODE are absent! (See the class website for a biology link.)

Section 9.5

- reading: the method of first integrals (equations 13 and 22) is important to know and understand. Many will find the subject of this section interesting.