Topics for Exam 3

1. **Flow of Linear Vector Fields in the Plane**

    1.1 Eigenvalues and eigenvectors.

    1.2 Phase portrait of linear systems.

        1.2.1 Line–solutions.

        1.2.2 Nullclines.

        1.2.3 Equilibrium points.

        1.2.4 Stability of equilibrium points.

        1.2.5 Classification of equilibrium points

            (i) Stable: Center, sink, spiral sink

            (ii) Unstable: Saddle point, source, spiral source

2. **Linear Functions and Liner Approximations**

    2.1 Linear and affine functions.

    2.2 Real–valued functions of two variables.

    2.3 Linear approximations.

    2.4 Partial derivatives.

    2.5 The gradient.

    2.6 The Chain–Rule.

Relevant sections in the online class notes: 5.4, 6.1, 6.2, 6.3, 6.4 and 6.5.

Relevant assignments: 14, 15, 16, 17, 18, 19, 20 and 21.

Important concepts: Eigenvalues and eigenvectors; phase–portrait; line–solutions; equilibrium points; nullclines; stability of equilibrium points: asymptotic stability, neutral stability, source, sink, saddle point, center, spiral sink, spiral source; cycles; linear approximations; partial derivatives; the gradient; the Chain–Rule.

Important skills:

- Know how to find eigenvalues and eigenvectors of 2×2 matrices.

- Know how to compute line–solutions of some linear systems.

- Know how to use nullclines, line–solutions (if any), and information on stability of the origin to sketch the phase portrait of linear, two–dimensional systems.

- Know how to classify equilibrium points of linear systems.

- Know how to compute partial derivatives.

- Know how to compute the gradient of a real–valued function of two variables.

- Know how to compute linear approximations.

- Know how to apply the Chain–Rule.