Assessment guidelines for FYS5190/FYS9190 (sensorveiledning)

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Practical arrangements

At the beginning of the exam each candidate will draw by lots a pair of questions. The candidate may, if they are uncomfortable with the results of the first draw, draw again, however, the candidate is then required to answer the second set of questions.

The questions asked are fairly broad, and intended to test the candidates conceptual understanding of the course content and the relations between the new concepts introduced, rather than technical calculational details. However, a good understanding of the algebraic structure of supersymmetry is necessary to achieve the A or B grades. The examiner (course responsible) will steer the candidates response by asking follow-up questions for clarification, further details, and/or correcting errors.

No preparation time will be given, and no aides are allowed. The candidate has around 40 minutes to answer the questions. Time will be kept by the examiner, and the examiner will make sure both questions are attempted by guiding the candidate. The role of the external assessor is mainly to listen to the answers given, however, they can supply more detailed follow-up questions if they feel the need to clarify points made by the candidate.

In the final section of this document you will find some sample exam questions organised in pairs as described above. We wish to emphasise that by giving these questions we are not implying that these particular questions will not appear on the exam, nor that they will.

Grading

The final oral exam counts for 70% of the grade. The remaining 30% is set based on the project.

The following descriptors are used to assess performances that would result in grades A, C, and E. The grades B (Very good), D (Satisfactory) and F (Fail) are given by interpolation from these.

Grade	**Name**	**Descriptor**
A	Excellent	The candidate shows a profound understanding of the models and concepts that were introduced in the course, and they have a very good overview of how these relate to each other. The candidate uses proper terminology, and their explanations are clear, precise, and well organized. The candidate appears as a full-fledged discussion partner for the examiners within the context of the curriculum. Minor inaccuracies are acceptable.
C	Good	The candidate is familiar with the most important concepts and understands the main features of the models that were introduced in the course, but may lack understanding of the greater picture of their relation to each other. Their explanations are understandable, but can have formal shortcomings, and terminology may be improperly used at times.
E	Sufficient	The candidate is familiar with a few concepts, but understands only the most basic aspects of the models that were introduced in the course. They fail to recognize the relation of the different concepts and models in a wider context. The candidate struggles to give explanations, and uses only very basic arguments. The candidate's statements are largely understandable, but reveal clear mistakes and misunderstandings.

Sample questions

- Describe the hierarchy problem and discuss how supersymmetry can help resolve it.
- Outline the derivation of the finite-dimensional irreducible representations of the $SU(2)$ group.
- Discuss the supersymmetric extension of QED using the generic supersymmetric action in terms of superfields

$$S = \int d^4x d^4\theta \left[\Phi^\dagger e^{qV} \Phi + \bar{\theta}\bar{\theta} W[\Phi] + \theta\theta W[\Phi^\dagger] + \frac{1}{2T(R)q^2} \bar{\theta}\bar{\theta} \mathrm{Tr}\{W^A W_A\} \right]. \tag{1}$$

- Explain what we mean by the irreducible representation of a (Lie) group, and how we can recreate the group (locally) using the exponential map.
- Discuss the properties of the electroweakinos (neutralinos and charginos).
- Argue how you can arrive at a differential representation of the superalgebra using superspace coordinates $z^\pi = (x^\mu, \theta^A, \bar{\theta}^{\dot{A}})$ and the super-Poincaré transformation

$$g_0(a, \alpha) = \exp\left[i a^\mu P_\mu + i \alpha^A Q_A + i \bar{\alpha}^{\dot{A}} \bar{Q}_{\dot{A}} \right].$$

- Write down a generic superfield in terms of component fields and explain the properties of the component fields. Disscuss the relationship between superfields and the representations of the superalgebra.
- Explain how supersymmetry can be broken spontaneously.
- Give the basic features of the MSSM mass spectrum. You are allowed to make GUT scale assumptions as you please.