Many (all) the questions have been answered during the Q&A period. Nevertheless, we ask that you provide written answers below so students can come back to read them again. Thanks!

1. *(Page 6) Does charge conjugation transform invert the weak isospin and the hypercharge?*

Charge conjugation replaces particle states with states their corresponding antiparticle states. So it does not change the magnitude of the hypercharge but it does change the sign (when the question was asked during the lectures I thought the question was about the magnitude, which is unchanged). For weak isospin since 2 and 2* representations are related by a similarity transformation, it does not change the isospin representation. For color group, it would change the state, let's say in a triplet of SU(3)_c, with an antitriplet. In terms of field operators, the transformation is C \psi C^-1 ~ \psi^* (where ~ means up to multiplying with some Dirac matrices, the explicit expression you can find for instance in eq. (3.145) of Peskin and Schroeder, An Introduction to Quantum Field Theory.

2. *(page 9) Can nonzero CP angles in the Yukawa couplings give enough CP violation for baryogengesis? Is the top Yukawa most important for this, or can all fermions participate in baryogengesis around the time of EWSB before Higgs takes a vev?*

Successful baryogenesis just using the observed DM states and observed CKM weak phase is not possible. For achieving electroweak baryogenesis just in the SM there are two problems: the phase transition is not first order, but rather a cross-over, and the overall effective amount of CP violation is small, i.e. the Jarlskog invariant is small. So that means that new physics is required. However, that does not mean that one necessarily need extra sources of CP violation. For instance, one can have decaying heavy particles, that preferentially decay into b quarks, and then one can use the CP violation that is already present in the SM to create the baryon asymmetry (this goes by the name of mesogenesis).

3. *Other than strong CP term, are the terms such as B_\munu dual B and W_\munu dual W for U1 and SU2 vanishing in the SM? From the experiment measurements?*

Yes, in principle you can write down also those terms, however they are not observable and are thus not physical. The reasons are a bit different between BBtilde and WWtilde terms. All of these terms, BBtilde, WWtilde and GGtilde are pure derivatives, and one can then integrate per parts in the action, and shift it into boundary terms. If for r->infty gauge fields drop to zero fast enough, these boundary terms give vanishingly small contributions and one can just drop them. This is the case for U(1) factors, while for non-abelian SU(2) or SU(3) there are instanton configurations that do not fall fast enough and contribute despite them being boundary terms (the result is just the winding number). However, for WWtilde one can perform an anomalous B+L transformation, which is classically conserved, but not quantum mechanically, which then changes the theta_weak.

This signifies that theta_weak is not observable, and can be set to zero (see also discussion in 1402.6340). Note also that there is no contradiction in the counting of physical parameters in CKM and UPMNS, since in each case we did not use one global quantum number, B, to get rid of parameters.

4. (Page 15) I don't understand the comment about moving flavor changing interactions to kinetic terms. Are we saying there is no more flavor changing interactions? I thought flavor changing interaction is an experimental observation and cannot disappear depending on how we write a Langrangian.

That is correct, the flavor changing and CP violation are experimentally observable and should not change whether or not one does field transformations. That is, applying unitary transformations on the fields should not have any observable effects. However, it is useful to diagonalize the mass matrices and move all the flavor violating parameters in the couplings with the W, since our probes (such as B mesons, kaons, etc) are mass eigenstates. In short, the origin of flavor violation and CP violation are the Yukawa matrices. However, conventionally we move this into the kinetic terms.

5. (Page 19) In this parameterization, the matrix has terms of Lambda^4. Can there be / are there phases in these additional terms?

There is only one physical weak phase (one CP violating parameter) in the CKM. However, once one performs an expansion in lambda, also this CP parameter will get expanded. Therefore in the O(lambda^4) corrections there will be complex terms, but they are all just the result of expanding one physical parameter.

6. Why don't we observe oscillations in the charged lepton sector?

Because there is a conserved quantum number: electric charge. It this were broken, oscillations could be possible.

7. Would CP violation in the leptonic sector account for the necessary amount of CPV?

I am assuming that the question is about successful generation of matter-antimatter asymmetry in the early universe. And yes, the leptonic sector can have enough CP violation to create this asymmetry (the so called leptogenesis), however this requires the existence of heavier sterile neutrinos, which were not yet observed.

8. Is it possible to relate the CP-phase in CKM matrix to the CP-phase in PMNS matrix?

One can imagine a common origin of the flavor structure in quark and lepton sectors, which would than also translate to a common origin of the two CP phases. There are several such models that were proposed, from Froggatt-Nielsen type models, to using discrete groups.

9. I was wondering if there can be CP violation with 2 generations of fermions if the neutrinos are Majorana

Yes, there would be one Majorana phase.