Lattice Methods in Quantum Field Theory - Straw Man outline

1. Phase Transitions and Critical Phenomena
   - The Ising Model of ferromagnetism
   - Hamiltonian, partition function, free energy, correlation functions
   - phase transitions and critical exponents
   - correlation length, universality
   - dictionary: statistical mechanics ⇔ euclidean QFT

2. Lattice Gauge Theory
   - link variables, plaquettes,
   - Wilson action and gauge invariance
   - classical continuum limit
   - Haar measure, no need to gauge-fix
   - Elitzur's theorem

3. Strong Coupling Expansion
   - Wilson loop at leading order
   - Area law and string tension
   - Static quark interpretation and confinement
   - other observables: glueballs, Polyakov line

4. Transfer Matrix
   - derivation in quantum mechanics
     - calculation of spectral quantities via temporal exponential decay
   - reflection positivity
   - T>0

~12 hour PGR course
first delivered to a general theory audience
at BUSSTEPP 1996,
and at an ECT* DTP in 2006

hand-written notes available at
http://pcwww.liv.ac.uk/~shands/lecture_notes.html

5. The Continuum Limit
   - Block spinning the Ising model
   - Renormalisation group and fixed points
   - Relation to QCD beta-function
   - Scaling vs. asymptotic scaling
   - The route to continuum, and why we need a computer to solve QCD

6. Monte Carlo Simulation
   - Importance sampling
   - Markov chain
   - Metropolis algorithm
   - Critical slowing down
   - Finite volume effects

7. Fermions
   - naive action, Grassmann variables, Mathews-Salam formulae
   - hopping parameter expansion, relation to vacuum polarisation
   - brief discussion of simulation of fermions and hadron spectroscopy
   - Fermion doubling, relation with the axial anomaly, Nielsen-Ninomiya theorem
   - Wilson fermions
   - staggered fermions
   - Ginsparg-Wilson, domain wall and overlap fermions

- Use plain background and simple sans-serif font on slides
- Use a limited colour palette and contrast text with $E = mc^2$
- Slow down animations/transitions to keep the pace reasonable
- Make sure talking head is well-lit and the background uncluttered
- Use a microphone

Some questions for discussion

Mistakes, hesitations and small slips are inevitable!
In a university lecture course there is plenty of opportunity to correct these, so quest for perfection is not an efficient use of time.

But for a web-based semi-permanent resource?

Use of closed captions to help non-native speakers and people with restricted hearing appears mandatory.
Zoom does a poor job and a lot of post-processing needed to correct.

Are there better solutions?

Clearly slides can easily be made available as a learning resource.
What about printed lecture notes and reading lists?
(Something we've all become used to providing in recent times…)

To what extent should we strive to ensure consistent notation, conventions, normalisations etc between different lecturers?