Solitons and instantons I.

1. The role of solitons and instantons classical and quantum theory, historical review, ‘mathematician’ and ‘physicist’ definitions.
2. $1+1 \text{ dimensional scalar fields}$ the structure of the space of $E < \infty$ configurations for one and more components, topological charge.
3. The kink model and the kink solution
5. The general condition of integrability zero curvature condition, non integrable phase factor, monodromia matrix, conserved quantities.
6. Derrick’s theorem and its modification when vector fields are present.
7. The $2+1 \text{ dimensional } O(3) \text{ model}$ topological classification, the Polyakov solutions.
8. The Dirac magnetic monopole and its properties.
9. The $d+1 \text{ dimensional spontaneously broken gauge theories}$
   the general properties of the $E < \infty$ solutions, the 2+1 dimensional Abelian Higgs model.
10. The t’Hooft Polyakov monopole spherically symmetric Ansatz, $\Pi_2(G/H) \sim \Pi_1(H)$ and the non integrable phase factor.
12. The Euclidean solutions their concept, the relation between the soliton and instanton solutions, the instanton interpretation of the previous soliton solutions.
13. The $3+1 \text{ dimensional pure Yang Mills theory}$ the classification of finite action solutions, Pontryagin number, (anti) self- duality equations.
14. The Yang Mills instanton solutions the BPST solution, the t’Hooft multi instantons, Witten’s $O(3)$ symmetric multi instantons.

Suggested reading
- R. Rajaraman “Solitons and Instantons” North Holland
- S. Coleman “Aspects of symmetry” CUP

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