**Coherent Questions:**

**Part 1:**

1. Define semiconductors. Give examples of devices/items used in a daily life exploiting properties of semiconductors?
2. Define excitons. Define Nanostructures. What are characteristic exciton lifetimes in different nanostructures?
3. Single excitons in quantum dots are often called “artificial atoms”. Is such a comparison correct?
4. Give examples of exciton complexes, what are their spectral signatures?
5. How one can spectrally tune exciton transitions in nanostructures?
6. Since a decade there’s been a growing interest in semiconducting transition metal dichalcogenides. Why is that? What is the best strategy to improve the quality of their optical response?
7. What are the similarities and differences between single emitters in QDs and TMDs ?
8. What are basic structural and electronic properties of halide perovskites? Give an example of their industrial applications.

**Part 2:**

1. How to efficiently inject light into a solid?
2. What is a figure of merit when maximizing light-matter interaction?
3. What is a Bragg mirror?
4. What is a planar/pillar microcavity?
5. What is a photonics waveguide antenna? How they can be fabricated?
6. What is a simplest architecture for in-plane waveguide based on a semiconductor?
7. How one can enclose quantum emitters into photonic devices in a deterministic fashion?

**Part 3:**

1. What are two defining features of Bose condensation?
2. What are microcavity exciton polaritons, what are their advantages/drawbacks for BEC?
3. What is the strong light-matter coupling regime?
4. What is Dicke superradiance?

**Part 4:**

1. What is the four-wave mixing (FWM) process?
2. What is the photon echo? What is its link with FWM?
3. What is optical heterodyning?
4. What is an acousto-optic modulator (or deflector) and its impact on a pulse train?
5. Why do we use the reference pulse?
6. Explain the balanced detection scheme using an AOM?
7. What is the spectral interferometry?

 **Part 5:**

1. What are Rabi rotations and how to measure them in the FWM experiment.
2. What is the pulse area?
3. Why is it useful to measure six-wave mixing on a single exciton?
4. What is phonon-induced dephasing?
5. FWM creation pathways in a four-level exciton-biexciton system.
6. Quantum beatings in a four-level exciton-biexciton system.

**Part 6:**

1. What is a quantum strong coupling regime?
2. Why using FWM spectroscopy to demonstrate quantum strong coupling in a solid?
3. Name solid state systems which can realize quantum strong coupling?

**Part 7:**

1. What is a coherent coupling?
2. What is a two-dimensional spectroscopy? Advantages? Requirements for implementation?
3. Signatures of coherent coupling in 2D spectroscopy?

**Part 8:**

1. Why applying heterodyne (colinar) FWM on TMD layers and heterostructures?
2. Revealing disorder induced localization of excitons. Correlations between: homogeneous, inhomogeneous broadenings, radiative lifetime and oscillator strength?