	Technology	Description	Learning Goals
1	Laser Cooling	Cooling atoms to the microkelvin regime with lasers using the Doppler effect.	• Learn about Doppler effect • How can the Doppler effect cool atoms? • Difference between red-shifted and blue-shifted light
2	Atom Trapping	Trapping atoms with magnetic fields and laser fields in a magneto-optical trap (MOT)	• Learn the working principle of a MOT • How is a MOT used to trap atoms?
3	Sub-doppler cooling	Cooling atoms further down below the Doppler limit by a process that depends upon the polarization of laser light and spin of atoms	• Working principle behind sub-Doppler cooling • Learn about the light shift
4	Ultra-stable magnetic field	Provides an ultra-stable magnetic field for atom trapping in the magneto-optical trap (MOT)	• Learn about anti-Helmholtz coils
5	Hot atom interferometry	Interferometry experiment with a warm vapour of Rubidium (Rb) atoms	• Learn about atom interferometry • How one can create interference patterns with Rb instead of a light source • How is atom interferometry different from optical interferometry?
6	Laser Locking	Locking the laser to an external frequency reference	• Need for laser locking • Working principle of laser locking
7	Temperature stabilization	Stabilizing the temperature of fibre optic cables, magnetic coils, and other experimental elements	• Importance of temperature stabilization

8	High-current field control	Controlling the high current that is used to control the magnetic field	• Learn the math behind the dependency of the generated magnetic field on the current through the Helmholtz coils
9	Leak detection	Making sure there is no leak in the vacuum system	• Importance of detecting leaks in the vacuum system • Procedure used for leak detection
10	Radio-frequency (RF) control	Using radio frequency (RF) control to manipulate magnetic traps	• Importance of RF control • How can radio-frequency signals be used to manipulate magnetic traps? • Parameters of the RF radiation to be controlled
11	Cold atom interferometry	Interferometry experiments with cold Rubidium (Rb) atoms	• Importance of cold atom interferometry and why is it an upcoming research field
12	Laser table stabilization	Stabilizing the laser table to ensure perfect alignment of laser beams and optics equipment	• Working principle behind stabilizing a laser table
13	Spatial Light modulation with DMDs	Shaping light by digital micromirror devices (DMDs)	• Learn about DMDs • What can be done with DMDs? • How are they useful?
14	Minimally-destructive atom imaging	Taking an image of the atomic cloud without disturbing the atoms in the trap	• Learn about an imaging technique called Faraday imaging
15	Advanced vacuum pumping	Advanced pumps for maintaining stable vacuum	• Learn about different kinds of pumps: ion pumps, getter pumps, turbo pumps

			• Learn about the experimental setup and vacuum system schematically
16	Evaporative cooling	Cooling down atoms further below the recoil limit	• Working principle behind evaporative cooling • Dependency on radio frequency control (a technology mentioned earlier)
17	Dipole Trapping	Technique to trap atoms based on induced dipole interactions with detuned light	• Interaction between an atom and a light field • Understanding a red-detuned trap • Understanding a blue-detuned repulsive barrier
18	Bose Einstein Condensate (BEC)	A new state of matter obtained from a collection of bosons in the ground state at ultra-cold temperatures (typically 100 nK or less)	• What are bosons? • How do we obtain Bose Einstein Condensation? • Properties of a BEC
19	Photonic crystal fibres	Special optical fibres to transport high power laser beams	• Difference between typical glass fibres and photonic crystal fibres
20	Dipole-trapped Bose Einstein Condensate (BEC)	Trapping a BEC in a dipole trap	• Using previous technologies like dipole trapping and photonic crystal fibres to trap a BEC
21	Fermion dispensers	Dispensers for fermions to conduct fermionic ultra-cold experiments	• Difference between bosons and fermions • Learn about Pauli exclusion principle • Working principle of a fermion dispenser
22	Bose Einstein Condensate (BEC) vortices	Studying quantized vortices in a BEC	• Learn about vortices • Understanding formation of vortices in a BEC

23	Ultra-cold interferometry	Performing interferometry experiments with atoms cooled to 100nK	• Advantages of ultra-cold atom interferometry over hot and cold atom interferometry
24	Optical Lattices	Creating lattice potentials with laser beams	• What is an optical lattice? • Learn how optical lattices are created • Learn about the different types of lattice structures
25	High-resolution imaging	A high-resolution imaging system to image atoms in optical lattices	• Basic principle of a high-resolution imaging technique (fluorescence imaging) • Knowing the camera system
26	Sympathetic cooling of fermions	A cooling technique where particles of one type cool particles of another type	• Primary principle behind sympathetic cooling • Why is it an effective cooling technique for fermions?
27	Advanced Quantum Sensing	Application of ultra-cold interferometry experiments for sensing experiments	• What are quantum sensing experiments? • Different kinds of quantum sensors • Why is quantum sensing an up-and-coming field?
28	Quantum Gas Microscopy	Imaging a quantum gas in an optical lattice with single-atom and single-site resolution	• Understanding the experimental setup of a quantum gas microscope • Application of fluorescence imaging (a technology learnt earlier)
29	Degenerate Fermi Gas	Creating a degenerate state of a fermi gas	• Application of the sympathetic cooling technique • What is Fermi energy? • What is the Fermi temperature • Dependence of the Fermi temperature on the particle energy

30	Spin addressing	Control over the spins of individual atoms using a quantum gas microscope	• Learn about the concept of spin • Mechanism of spin flipping
31	Deterministic loading of a single atom	Loading a single atom from a Bose Einstein Condensate (BEC) in an optical tweezer	• Mechanism of loading atoms from a BEC • What are optical tweezers?
32	Fermi-gas microscope	Creating a quantum gas microscope using fermions	• Revisiting the quantum gas microscope created with fermions • Getting perspective about the length and time-scales of site-resolved imaging
33	Fermi-Bose mixtures	Probing a mixture of Fermi and Bose gases to study a variety of many-body physics	• What is a Fermi-Bose mixture?
34	Cold atoms in space	Creating Bose Einstein Condensates (BEC) in space	• Learn about NASA’s Cold Atom Lab (CAL) • Advantages of creating a BEC in the microgravity environment of the International Space Station