Modern Physics – scope for exam in 2016 for Electronics and Telecommunication in English

1. **Revision on electromagnetic waves**

force and potential energy, nabla operator and its function as a gradient, divergence and curl, practical exercises of calculations including grad, div and rot (curl), flux and divergence operator (definition and Gauss law), circulation of vector field and curl operator (definition and Ampere law), examples of irrotational fields, Stokes theorem, Maxwell equations in differential and integral forms, electromagnetic wave in vacuum (derivation of wave equation), general form of wave equation, velocity of electromagnetic wave, propagation of electromagnetic wave (Poynting vector),

2. **Historical introduction to quantum mechanics**

blackbody radiation, Wien displacement law, Boltzmann law, Planck's formula, Einstein contribution to description of blackbody radiation, photoelectric effect, Compton effect

3. **Waves as particles and particles as waves**

photon energy, photon momentum, energy-frequency dependence, matter waves, de Broglie relation, Davisson-Germer experiment

4. **The Schrödinger equation**

particles as waves – description of interference experiment, probabilistic interpretation of wave functions, time-dependent Schrödinger equation, representation of plane waves, separation of Schrödinger equation, time-independent Schrödinger equation, eigenfunctions and eigenvalues of the Hamiltonian, infinite quantum well, quantization of energy, dispersion relation

5. **Wave packets and the uncertainty principles**

construction of wave packets, Heisenberg position-momentum uncertainty relation, Heisenberg microscope, interpretation of two-slit experiment, time-energy uncertainty relation and its consequences

6. **Barriers and wells**

solution of Schrödinger equation for rectangular potential barrier, **tunneling:** theory and examples, alpha decay, nuclear fusion, scanning tunneling microscope STM, finite quantum well:bound states, electron traps: nanocrystallites, quantum dots, quantum corral

7. **Models of simple atoms**

degenerate state, early models of atoms, Bohr theory of hydrogen atom, quantization of angular momentum (one of the postulates), energy levels, interpretation of emission and absorption spectra of atoms, correspondence principle

8. Hydrogen atom in quantum mechanics

solution of Schrödinger equation for central Coulomb potential, radial functions and spherical harmonics, quantum numbers, energy eigenvalues for hydrogen, angular momentum, orbital magnetic dipole moment, electron spin