**BEN-GURION UNIVERSITY OF THE NEGEV אוניברסיטת בן-גוריון בנגב**

**DEPARTMENT OF ELECTRO-OPTICS ENGINEERING מחלקה להנדסת אלקטרואופטיקה ופוטוניקה**

**Fiber Optics for Optics Communication**

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**Simulation: numerical modeling task** Detail your answers.

One of the winning devices has been the single-mode fiber, having a step-index profile with a higher refractive index in the center core and a lower index in the outer cladding. Today’s fibers have losses near the theoretical limit of 0.16 dB/km at 1.55 μm (near-infrared light). Numerical software plays an important role in the design of single-mode waveguides and fibers. For a fiber cross section, even the simplest shape is difficult and cumbersome to deal with analytically.

Consider a multimode step-index fiber made of silica glass with the inner core of radius *a*  made of pure silica glass with refractive index n1 = 1.4457, and the cladding is doped with a refractive index of n2 = 1.4378 while the free-space wavelengths of 1.55 μm so n1>n2>>n3. The radius of the cladding is >> *a* so that the field of confined modes is zero at the exterior boundaries.

1. (20) Find an effective mode index of a confined guided mode and the propagation constant for TM and TE (are they the same?). What would be the *V* number? Plot the dispersion maps and relate the guided modes m and V-number. Note: $n\_{1}<\tilde{n}<n\_{2} , n=β/k\_{0}$ and $V=a\sqrt{p\_{m}^{2}+q\_{m}^{2}}=\frac{2πa}{λ}\sqrt{n\_{1}^{2}-n\_{2}^{2}}$
2. (10 points) Calculate and show the field components of guided modes of the fiber.
3. (10 point) Characterize the modes: *TE* mode/*TM* mode/*HE*mn/*EH*mn.
4. (25 points) What are the *E*z,m(,,*z*) components in the core (≤a) and the cladding (>a)? Present the analytical derivation and show the numerical field distributions.
5. (10 points) Draw *E*z,m(,,*z*) components in the core (≤a) and the cladding (>a) as a function of: a) radial component, b) azimuthal component and c) in propagation direction.
6. (10 points) Draw *H*z,m(,,*z*) components in the core (≤a) and the cladding (>a) as a function of: a) radial component, b) azimuthal component and c) in propagation direction.
7. (15 points) Calculate the: a) effective core area(4 points), b) confinement factor (4 points), c) group velocity dispersion (7 points).