STUDIES ON SINGLE MODE FIBER CHARACTERISTICS

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DOCTOR OF PHILOSOPHY

by
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CERTIFICATE

This is to certify that the thesis entitled "STUDIES ON SINGLE MODE FIBER CHARACTERSTICS" being submitted by Mr. Vishnu Priye to the Indian Institute of Technology, Delhi for the award of the degree of DOCTOR OF PHILOSOPHY, is a record of bonafide research work carried out by him. Mr. Vishnu Priye has worked under our guidance and supervision and has fulfilled the requirements which to our knowledge have reached the requisite standard for the submission of this thesis. The results contained in this thesis have not been submitted in part or full to any other University or Institute for the award of any degree or diploma.

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ABSTRACT

In the present generation of optical fiber communication systems, single mode fibers are being extensively used due to its low dispersion low loss and high bandwidth. The most ideal single mode fibers, for the purpose of communication, is the step index fiber for which the modal field is exactly known in terms of Bessel and modified Bessel functions. However, the fibers fabricated by the present technology, inadvertently show deviations in the step index profile.

To estimate the performance of single mode fibers, in practical situations, an accurate description of the modal field pattern of the fundamental mode is required. The modal field itself can be conveniently characterised by its mode field radius (MFR) also known as spot size. It has been observed that to realise all the informations, Such as source to fiber coupling, splice loss, microbending loss etc. regarding the performance of the single mode fiber, one requires to know two kinds of spot sizes W_{rms} and W_p. W_{rms} is known as the near field r.m.s. spot size and W_p is the Petermann spot size of the second kind. We have studied the applicability and accuracy of a simple technique which predicts the two spot sizes from a single measurement of the far field intensity distribution.

During the process of installation, there is a high probability of the single mode fiber getting bent. Extensive theoretical and experimental studies have revealed that in a bent fiber the fundamental modal field shifts away from the axis and its width reduces in the process. We have studied the shift and the 3 dB width of the fundamental modal field of a bent step index fiber using a perturbation approach. We have also extended our approach to fibers of arbitrary refractive index profile.

For a single mode fiber, the cut off frequency (V_c) of the first order mode is an important parameter. We have studied the effect on V_c due to the presence of sinusoidal ripples in the core refractive index distribution of single mode graded index fibers. The presence of such radial ripples were experimentally reported and are due to the finiteness of individual deposited layers in single mode MCVD fiber preforms.

The double clad single mode fibers with depressed index cladding (DIC) are characterised by low dispersion over a relatively wide wavelength range. Hence a DIC fiber has a potent application in Wavelength division multiplexed systems. In practice, refractive index porfile of DIC fibers exhibit a layered structure in the depressed inner cladding and an axial dip in the core due to the deposition conditions

encountered in the MCVD process. We have studied the effect of such imperfections in RIP on the leakage loss of the fundamental mode in DIC fibers. Our study is based on a numerical matrix technique for leaky and/or absorptive waveguides.

The dual mode elliptic core fiber, due to its modal stability at the output is finding wide application in fiber optic components/devices and sensors. In the concluding study, we have analytically investigated a dual mode elliptic core fiber which is longitudinally strained. Our study is in conformity with the earlier reported experimental results. A rectangular waveguide model for the elliptic core fiber forms the basis of our analysis to study performance of an elliptic core dual mode fiber as a strain gauge.

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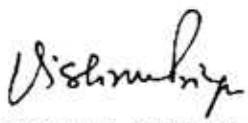

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