DECLARATION

I hereby declare that the thesis entitled “RADIATION DOSIMETRY AND TREATMENT PLANNING FOR INTENSITY MODULATED RADIATION THERAPY CANCER TREATMENT” submitted by me, for the award of the degree of Doctor of Philosophy to VIT University is a record of bonafide work carried out by me under the supervision of Dr. R. Jagadeesh Kannan, Professor, School of Computing Science and Engineering, VIT University, Chennai.

I further declare that the work reported in this thesis has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Place: Vellore
Date: 20.06.2018
Signature of the Candidate
CERTIFICATE

This is to certify that the thesis entitled “RADIATION DOSIMETRY AND TREATMENT PLANNING FOR INTENSITY MODULATED RADIATION THERAPY CANCER TREATMENT” submitted by Mr. K. NARESH, School of Computing Science and Engineering, VIT University, Vellore for the award of the degree of Doctor of Philosophy, is a record of bonafide work carried out by him under my supervision, as per the VIT code of academic and research ethics.

The contents of this report have not been submitted and will not be submitted either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university. The thesis fulfills the requirements and regulations of the University and in my opinion meets the necessary standards for submission.

Place: Vellore
Date: 20.06.2018

Signature of the Guide
ABSTRACT

The process of radiotherapy involves irradiating radiation in the tumours to destroy cancer cells shielding healthy tissues and vital organs from the effect of radiation. Therefore the objective of this paper is an effort for understanding the Intensity Modulation Radiation Therapy (IMRT) machine along with its treatment planning. The radiotherapy terminologies that enumerates details about Dose Volume Histogram (DVH), bixels, voxels and the standard for sharing medical images compatible with various devices known as Digital Imaging Communications in Medicine (DICOM). Finally the optimization techniques involved in cancer treatment using Intensity Modulation Radiation Therapy (IMRT) is formulated. The linprog tool in MATLAB is used to solve the formulated Linear Programming Problem (LLP) to illustrate the application of operation research in radiotherapy.

Optimization techniques play a vital role in cancer treatment through irradiation. Complex system such as IMRT equipment involves beam angle optimization for fixed rotation of gantry to deliver radiation beams to the tumor target avoiding the healthy tissues and vital organs. Fluence-map optimization enables non-uniform distribution of radiation aided by Multi-leaf Collimator (MLC) of IMRT to shrink the target with high intensity, maintaining low intensity for organ at risk. Therefore beam shaping with respect to the geometry of the tumor region satisfying the mechanical constraints of MLC is addressed in this paper. The MLC can be represented in Matrix to synchronize with the tumor geometry. This matrix is
converted to weighted directed graph to which Bellman-Ford algorithm is applied to find the optimal aperture to irradiate the large area of tumor region.

The People around the world are generally exposed to both ionizing and non-ionizing radiation. The ionizing radiations are harmful to the human beings existing within the proximity of these irradiative sources. Therefore the purpose of this paper is to list the sources of ionizing radiation, its effect on human body by detection and measurement. Usually the measurements of ionizing radiation are done by dosimeters. The quantities associated with dosimeters like absorbed dose, effective dose and equivalent dose are also discussed. Specifically the method of dose estimation using Thermo Luminescent Dosimeter (TLD) along with its design constraints is enumerated. The ionizing radiation from the irradiative sources is incident on TLD badge filled with luminance material. This material acquires the ionizing radiation in the form of trapped energy which is directly proportional to the number of photons generated from the irradiative sources. After a short period of a week or one or six-month as per international standards the badge is processed by the TLD reader system to estimate the absorbed dose within that specified time period. Finally the working mechanism of the TLD reader system is also discussed.

**KEYWORDS:** Digital Imaging Communications in Medicine (DICOM), Intensity Modulation Radiation Therapy (IMRT), Linear Programming Problem (LPP), Dose Volume Histogram (DVH), Multi-leaf Collimator, weighted directed graph, radiation, Ionizing radiation, Dosimeter, Absorbed Dose, Effective Dose, Equivalent Dose, TLD.