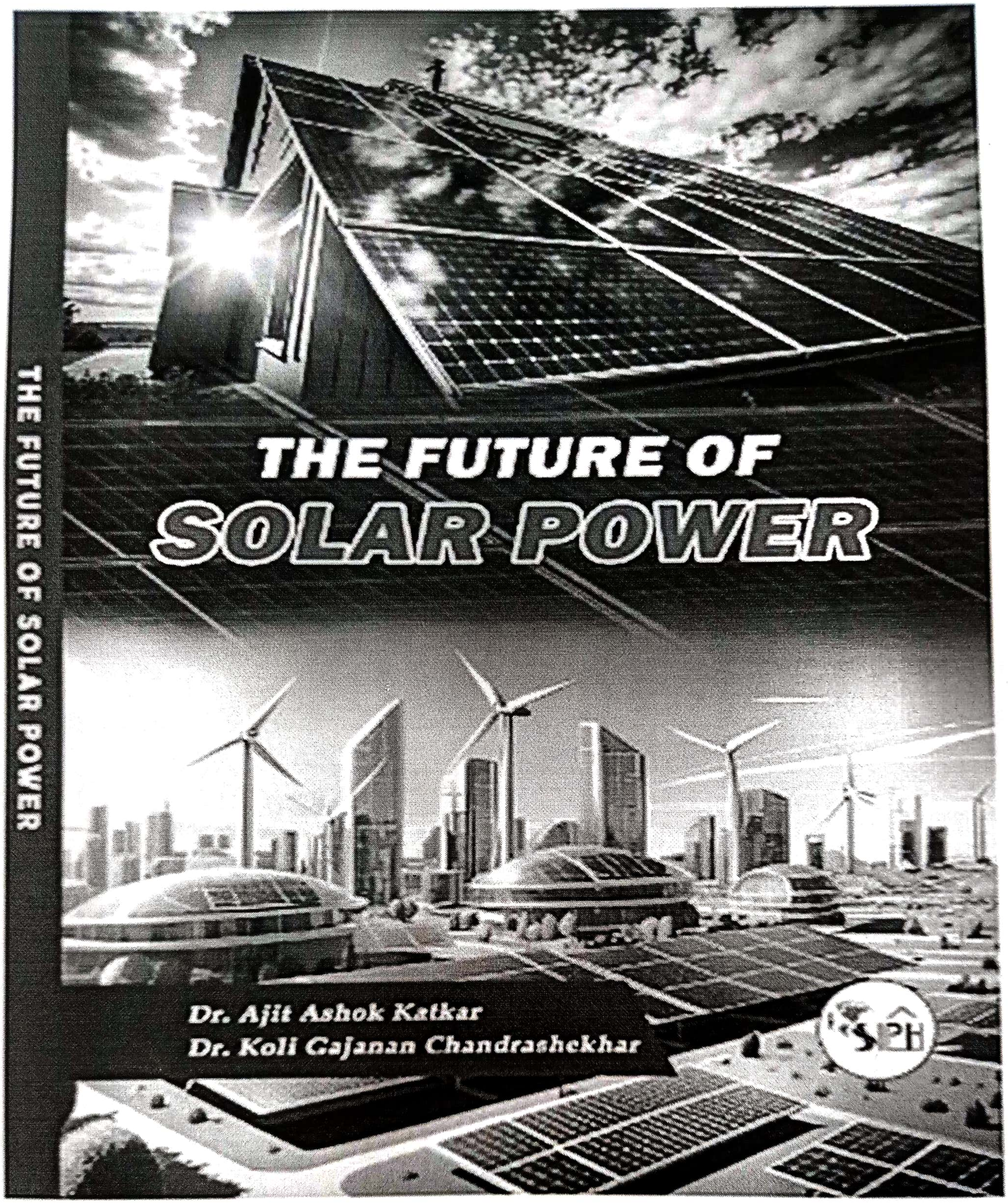
3.2.2 Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during the year

Sr. No.	Name of the teacher	Page No.
1	Dr. Koli Gajanan Chandrashekhar	1
2	Dr A.A.Katkar	1
3	Dr A.A.Katkar	2
4	Dr A.A.Katkar	3



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Rahul Ramesh Joshi, Sanjay Hari Sawant, Sonali Patil and Ajit Ashok Katkar

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Frequency Domain Diagnostics for Faults in a Bevel Gearbox

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Abstract: This study experimentally validates frequency domain analysis for fault diagnosis in a single-stage bevel gearbox. Vibration signals were acquired from a test rig under varying speeds and loads for nine conditions: healthy, isolated gear faults (wear, pitting, corrosion, fracture), isolated bearing faults (wear, pitting), and combined gear-bearing faults. The results demonstrate that characteristic frequencies provide definitive fault signatures. Gear faults, particularly fracture, elevated vibration amplitude at the gear mesh frequency and its harmonics. Bearing defects were identified by increased amplitude at their specific pass frequencies. Combined faults produced a superposition of these spectral features, with the coalesced gear fracture and bearing wear condition generating the most severe vibrational response. The method conclusively discriminates between fault types, providing a critical tool for precise condition monitoring of bevel gearboxes.

Keywords: Fault Diagnosis, Vibration Analysis, Frequency Domain, Bevel Gearbox, Combined Faults.

1. INTRODUCTION

Rotating machinery forms the backbone of modern industry, with gearboxes being pivotal for mechanical power transmission. Among these, bevel gearboxes are essential for applications requiring a change in the direction of shaft rotation, such as in automotive differentials, power plants, and heavy machinery. The continuous and often harsh operational demands make these systems susceptible to faults like gear tooth wear, pitting, fracture, and bearing degradation [1, 2]. A sudden failure can lead to unplanned downtime, costly repairs, and safety hazards.

Vibration analysis has emerged as one of the most effective non-intrusive techniques for condition monitoring and fault diagnosis [3, 4]. While time-domain analysis (e.g., Root Mean Square - RMS) provides an overall measure of vibration severity, frequency-domain analysis offers deeper insights by decomposing the complex vibration signal into its constituent frequencies [5]. This allows for the identification of specific fault signatures, such as Gear Meshing Frequency (GMF) harmonics for gear faults and Ball Pass Frequencies for bearing defects [6, 7].

Although extensive research exists on fault diagnosis for spur and helical gears, studies focused on bevel gearboxes, especially those considering combined gear and bearing faults, are relatively limited [8]. This research gap is addressed in this paper, which presents a detailed experimental investigation into the vibrational behavior of a single-stage bevel gearbox. The primary objective is to evaluate the effectiveness of frequency-domain analysis in detecting, isolating, and characterizing various single and combined faults under different operating speeds and loads.

2. MATERIALS AND METHODS

2.1 Experimental Setup

A dedicated test rig was designed and fabricated to simulate the operation of a single-stage bevel gearbox, as shown in Figure 1. The major components include:

1. Prime Mover: A 1 HP, 220V, 3000 rpm permanent magnet DC motor.
2. Gearbox: A single-stage bevel gearbox with a 20-tooth pinion and gear (Module: 2 mm).
3. Bearings: SKF 30205 single-row tapered roller bearings.