The PHILIPPINE ENGINEERING JOURNAL serves as a national medium of exchange of technical information and dissemination of engineering knowledge through the publication of technical papers, technical notes, and research briefs. Published by the U.P. Engineering Research and Development Foundation, Inc. for the National Engineering Center, the PHILIPPINE ENGINEERING JOURNAL is being distributed at reasonable rates to various government agencies, private industrial concerns, engineering schools, professional organizations, international entities and practitioners in the field of engineering.

ISSN 0117 5564

AURA C. MATIAS, Ph.D. Executive Director National Engineering Center

Rizalinda L. De Leon, Ph.D. Editor-in-Chief

EDITORIAL BOARD

Dr. Menandro Berana
Dr. Ariel Blanco
Dr. Louis Angelo Danao
Dr. Leslie Ann Diaz
Dr. Richard Hizon
Dr. Iris Ann Martinez
Dr. Jose Muñoz
Dr. Prospero Naval
Dr. Ma. Antonia N. Tanchuling
Dr. Karl N. Vergel

Erwin Gabriel Publication Staff

Mailing Address: Rm 207 Juinio Hall UP National Engineering Center UP Campus Diliman, Quezon City 1101 Telefax: (632) 929 1710 Telephone Numbers:

Trunkline Line: 981-8500 loc. 3006

Direct Line: (632) 927-1581