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Robust second-order rotatable invariably designs for some lifetime distributions

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ABSTRACT

First-order rotatable designs for the lifetime response with distributions such as lognormal, Weibull, gamma, and exponential, assuming autocorrelated errors have been studied. A first-order model in practice is an adequate approximation to the true unknown surface in a small region of the explanatory variables *x*'s. For an unknown experimental region or a system with any curvature, then the second-order model is always appropriate. It is aimed herein to extend the above ideas in the current paper for second-order models. Second-order lifetime correlated models along with rotatability conditions have been derived in the paper. Invariant (independent of the above considered four distributions) robust (independent of the correlation parameter values) second-order rotatable designs have been derived for the autocorrelated error structure. The derived designs in the paper are robust second-order rotatable for all values of the autocorrelation coefficient, and for all the above considered four lifetime distributions. The present derived designs in the paper satisfy four lifetime distributions with autocorrelated errors, while the usual uncorrelated second-order designs are unable to satisfy the similar conditions. In this sense, the current designs are most appropriate for lifetime improvement experiments.

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Autocorrelated errors; invariant designs; lifetime response surface models; mean lifetime; robust second-order rotatability

1. Introduction

In response surface methodology (RSM), it is assumed that the response follows normal distribution with uncorrelated and homoscedastic errors (Box and Hunter 1957; Box and Draper 2007). In lifetime advancement experiments, generally, response surface designs are used for identifying the optimal level combinations to achieve the specific target (Nair et al. 1992; Myers, Montgomery, and Vining 2002). Note that lifetime response generally follows exponential, gamma, lognormal, Weibull distributions (Lawless 1982; Das and Lee 2008; Das 2013). Moreover, lifetime observations can be correlated (Myers, Montgomery, and Vining 2002). Therefore, uncorrelated homoscedastic and normally distributed (usual) response surface designs are not suitable for lifetime advancement experiments, as the usual RSM does not satisfy the lifetime

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