

## Model Development for Damped and Forced Type of Oscillations in Time Series

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## ABSTRACT

The motion which repeats after a regular interval of time is defined as periodic motion. The periodic motion in which there is existence of a restoring force and the body moves along the same path to and fro about a definite point called equilibrium position/mean position, is called oscillatory motion. The oscillatory motion could be either linear oscillation or circular oscillation. For examples, the oscillation of strings of musical instruments is linear oscillation whilst the oscillation of simple pendulum of a clock is circular oscillation. A wave is a correlated collection of oscillations. For example, in a wave traveling along a string, each point in the string oscillates back and forth in the transverse direction (perpendicular to the direction of the string); in sound waves, each air molecule oscillates back and forth in the longitudinal direction (the direction in which the sound is traveling). Therefore understanding oscillatory motions is the base of understanding waves. Oscillatory motions and wave like patterns are common in time series data as well. For examples, number of infected cases of a disease in epidemiology; species migration in ecology, human blood sugar or blood pressure levels in biology; harvest of crops in agriculture; behavior of consumer price index in economics; share returns in finance; number of arrivals to a cultural landscape in tourism management etc. follow regular or irregular wave like patterns. The Auto Regressive Integrated Moving Average (ARIMA), Seasonal Auto Regressive Integrated Moving Average (SARIMA), Circular Model (CM) and Sama Circular Model (SCM) were successful in modeling such series. The literature revealed that the daily infected cases of Covid 19 show irregular wave like patterns with; increasing amplitudes, decreasing amplitudes or both, but none of the existing time series forecasting techniques are capable in capturing them. Pattern of these series are somewhat similar to the pattern of Damped oscillation and Forced oscillation described in Physics. Hence the authors of the study intended to develop suitable forecasting techniques to model such time series and developed two new stochastic models named; Damped Circular Model (DCM) and Forced Circular Model (FCM). The development of the models were based on, Circular model, which was based on Simple harmonic motion; theory of Damped and Forced Oscillations and the Second order Differential Equations. It is recommended to test the DCM and FCM on real life data in the fields of epidemiology and others.

Keywords: Circular Model (CM), Damped Oscillation, Forced Oscillation