Instructions:
1.) *Answer all the ten questions*
2.) *All questions carry equal marks*
3.) *Assume, any relevant data if required, with justification*

Q.1 Write short notes on the following:
(a) Non Destructive Test Techniques
(b) FMECA
(c) Oil Whirling o
(d) Coherence

Q.2 A centrifugal pump is driven by a 4 pole induction motor through a flange coupling. If the supply line frequency is 50 Hz, and the pump impeller having 24 vanes is supported on two deep groove ball bearings. Calculate the prominent frequencies expected in the vibration spectra obtained by a tri-axial accelerometer mounted close to one of the bearings supporting the impeller. The bearing data are as follows: Number of rolling elements = 12; Pitch Diameter = 35 mm; Ball Diameter = 8mm; Bore Diameter = 12mm.

Q.3 Describe how in a multi-stage gas turbine for a MIG-27 fighter jet one can identify the following faults, while the fighter jet is airborne. List the instrumentation required for such purposes, with their desirable frequency response and dynamic range. Take special care of the high temperatures around the gas turbine exhaust end for instrumentation aspects.

(a) Loss of compressor pressure
(b) Eccentricity in the power train shaft of the turbine
(c) Rotor blade damage in the low pressure compressor

Q.4 Describe with a block diagram the working of an FFT analyzer, showing the important components. Indicate how FFT analysis in different bandwidths is done without aliassing the signals.

Q.5 Describe the principle behind the working of the following equipment.
(a) Hall effect sensor
o(b) Atomic Absorption Spectrophotometer ——
(c) Piezoelectric pressure gage ·
(d) Infra Red Temperature Detector

Q.6 Derive from fourier analysis an expression for the 3rd and 5th harmonic amplitudes of a 10 Hz square wave with no mean component and a peak amplitude of 10 V.

Q.7 A signal is given by the equation $x(t)=10.0\cos200t$ Volts and t is in seconds. If this signal is to be acquired digitally for a total duration of 20 seconds, determine the amount of on board memory in bytes, required in the data acquisition card to store the digitized signal samples. Assume the A/D card to be of 12 bit.

Q.8 Distinguish between the following:
- (i)   Signal Beating and Signal Modulation
- (ii)   Auto Power Spectrum and Cross Power Spectrum
- (iii) Mechanical Impedance and Mobility
- (iv)   Fast Fourier Transform and Discrete Fourier Transform

Q.9 Derive an expression for the current drawn by a single phase induction motor with a supply frequency of f_e loaded by a mechanical torque at a frequency of f_1 and show that the current thus drawn is amplitude modulated. Assume any information regarding the motor required for the derivation of this expression.

Q.10 Explain the significance of engine oil quality monitoring and list the tests done to monitor the oil quality.