Vibration Institute

CERTIFICATION HANDBOOK

FOR VIBRATION ANALYST CATEGORIES I-IV

THE VIBRATION INSTITUTE 1/31/20 REVISION 8

Vibration Institute

CERTIFICATION HANDBOOK

FOR VIBRATION ANALYST CATEGORIES I – IV

#0845
ISO/IEC 17024
Personnel Certification Program

The Vibration Institute

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CERTIFICATION HANDBOOK FOR VIBRATION ANALYST CATEGORIES I – IV

ABOUT THIS CERTIFICATION HANDBOOK

The Vibration Institute Certification Handbook contains a description of the Institute's certification program for Vibration Analyst.

The Vibration Institute Certification Program for Vibration Analyst is an ANAB-Accredited Personnel Certification Program – Accreditation #0845. ANAB is the ANSI National Accreditation Board. The accreditation by ANAB assures that the Institute's certification program is valid, reliable, impartial, and provides fair and equal access to the certification policies and procedures that assess the qualifications of candidates on a standardized basis. The Certification Handbook includes information on:

- Benefits
- Recognition
- Terms of certification
- Body of knowledge for certification
- Recommendations for education, and requirements for training and experience
- Examination requirements
- Sources for self-study and review
- Sample test questions

SCOPE

The Vibration Institute's certification program provides third-party conformity assessment of individuals to determine their competence as a Vibration Analyst at a given category. If determined to have attained the minimum requirements, the Vibration Institute, as an accredited third-party conformity assessment body, issues a five-year certificate to the individual. There are four categories of certification.

When a certificate is issued, the Vibration Institute attests to the minimum qualification of a candidate as defined in ISO 18436-2 and this Handbook. The employer or self-employed individual is responsible for the authorization to perform machinery condition monitoring and diagnostics and, as a result, is responsible for the quality and validity of their work.

In order to assure continued competence, ISO standards require periodic recertification either by re-examination or renewal (i.e. providing evidence of continued work experience and ongoing qualifying professional development). Currently, that period is five years.

Thank you for considering the Vibration Institute's certification program. We hope that you will benefit both professionally and personally from the distinction of being certified by the Vibration Institute.

Sincerely,

RJ Sayer	David Corelli
Robert J. Sayer, PE President Vibration Institute	David Corelli Technical Director-Certification Vibration Institute

ABOUT THE VIBRATION INSTITUTE

MISSION

The mission of the Vibration Institute is to disseminate practical information on evaluating machinery behavior and condition without commercial interest. The Institute offers programs including education, training, and certification. Opportunities for exchanging technical knowledge, information, procedures, and data are offered through meetings, formal training, publications, and networking.

HISTORY

The Vibration Institute evolved from an idea more than 40 years ago by the late Michael Blake of Lovejoy, Inc. He believed strongly that an organization was needed that would allow individuals from any industry to share information about measuring and analyzing vibration, even though vibration technology was not then being widely used in predictive maintenance. In 1967 Blake organized, and Lovejoy sponsored, a small symposium for exchanging information about the techniques then being used to measure vibration. In 1972 the late Pat Hennessy, President of Lovejoy, assumed the responsibility and expense of incorporating the nonprofit Vibration Foundation. The Foundation was reorganized in 1973 into the Vibration Institute. Hennessy, Blake, Charlie Jackson, and Ron Eshleman were among the original Board of Directors given the challenge of making something of the Institute and the "Blake Concept." After 1973 the Institute evolved into a service organization providing membership, training, and the opportunity to exchange concepts and ideas about vibration measurement and analysis.

In 1992 a Certification Committee was formed by the Vibration Institute to consider a program for certification of individuals in machinery vibration. Committee members included practicing vibration analysts active in a broad spectrum of disciplines – machine tool; pulp, paper, and printing; petrochemical; power; and consulting. The motivations for the establishment of the certification program were personal, client and corporate acknowledgement, and recognition of levels of expertise. The consensus of the Committee was that certification would add credibility to the vibration profession. The Vibration Institute committee developed a certification Scheme with 3 levels of certification. This Scheme became the basis for the international Standard ISO 18436-2, which is, the de facto standard in the world today for vibration analysts in condition monitoring. In January 2003 the Institute officially adopted ISO 18436-2 as the Body of Knowledge for our certification program and changed from offering three (3) levels of certification to four (4) categories.

CERTIFICATION (SCHEME) COMMITTEE

The Certification Committee, also known as the Scheme Committee, is comprised of Vibration Institute certificate holders who represent industry, academic, and government interests. The Certification Committee member term is three years and is renewable based on interest, attendance, and participation in committee work. The committee meets two to three times per year and the members are practicing vibration analysts and experienced technicians in machine condition monitoring and diagnostics. Duties of committee members include participation in the ISO committee to update 18436 Standards, cut-score studies, item (question) and examination development, item analysis, and certification policy development. The committee also has the responsibility of periodic evaluation of the certification scheme including expanding or reducing its scope.

Members of the Certification Committee are required to sign an agreement that ensures confidentiality, ethics, and competency and are also required to avoid situations where a conflict of interest may occur and when outside commercial interests may pose a potential threat. If you are interested and feel you are qualified to participate on the committee, contact the Vibration Institute.

AMERICANS WITH DISABILITIES ACT (ADA)

The Vibration Institute complies with the following requirements of the ADA:

- The use of handicapped accessible facilities
- The removal of "readily achievable" physical barriers in meeting rooms.
- The provision of auxiliary aids and services to assure effective communication.
- The modification of the Institutes policies, practices, and procedures applicable to candidates to enable disabled individuals to participate equally in the program. For example, persons visually, vocally, or language (English) handicapped.

EQUAL OPPORTUNITY EMPLOYER AND CERTIFYING BODY

The Vibration Institute is an equal opportunity employer and assessor of candidates without discrimination due to age, sex, sexual orientation, race, religion, or ethnicity.

ACCREDITATION

The Vibration Institute is an accredited, third party Certifying Body for the certification of persons in the area of vibration condition monitoring and diagnostics. The Institute is accredited to ISO/IEC 17024 by ANAB (ANSI National Accreditation Board) in accordance with both ISO 18436-1 and ISO 18436-2.

VIBRATION ANALYST CERTIFICATION PROGRAM

PROGRAM DEVELOPMENT AND ORGANIZATION

The Vibration Institute's Certification Scheme for Vibration Analyst was developed by, is maintained by, and is governed by a committee representing various industries and is used worldwide. The Vibration Institute's Certification Program follows ISO 18436, Condition monitoring and diagnostics of machines - Requirements for qualification and certification of personnel – Part 1: Requirements for certifying bodies and the certification process; Part 2: Vibration condition monitoring and diagnostics.

BENEFITS

The Vibration Institute's Certification Program is a focal point for acknowledging the capability and motivation of individuals in the vibration field. It provides professional recognition by clients, employers, and colleagues and acknowledgment of proven capability in the category certified.

RECOGNITION

Certified individuals are listed annually, by certification category, in *Vibrations* magazine and on the Institute's website at www.vi-institute.org. Certificates, and photo identification cards upon request, are issued by the Institute at the time of certification which contains relevant information about the category of certification of the individual. Additionally, ink stamps and embossers are also available to certified individuals. Please contact the Vibration Institute for more information.

TERM OF CERTIFICATION AND RECERTIFICATION

Certification is valid for five years. Recertification is required every five years by either reexamination or renewal. Renewal requires providing the Vibration Institute written evidence of ongoing satisfactory vibration related work experience and qualifying professional development. The Vibration Institute will attempt to notify certificants of their expiration date in advance so they can submit the required recertification application and not have a lapse in their certification. However, it is the responsibility of the certificants to renew even if they do not receive notification by the Institute (e.g. contact information has changed). If a certificant does not recertify by their certification expiration date, they are no longer certified and cannot state so until they are recertified.

If an individual passes a higher category exam during their 5-year certification period, a new five-year period begins before recertification/renewal is required.

CAPABILITIES OF CERTIFIED VIBRATION ANALYSTS

CATEGORY I CERTIFIED PERSONS

...shall be capable of safely collecting routine route data using a data collector. They must know the basic principles of mechanical vibration, including, units of measures used for condition monitoring of machinery. They are to be capable of performing reliable pre-determined single channel vibration measurements, comparing such measurements against pre-established alarms, identification of errors in collected data, reporting on visual observations on the condition of equipment, and transferring collected data to a computer-based system.

CATEGORY II CERTIFIED VIBRATION ANALYSTS

...shall have all the knowledge and capability of a Category I Certified Person. They shall be capable of defining routine data collection activities including acquisition and analysis settings using basic signal analysis, collecting extra test points when unusual conditions exist, performing single channel impact tests, interpreting and evaluating test results in accordance with specifications and standards, diagnosing common faults, and recommending basic corrective actions. The Analyst shall be aware of and capable of recommending alternate condition monitoring technologies to verify issues raised as a result of routine condition monitoring.

CATEGORY III CERTIFIED VIBRATION ANALYSTS

...shall have all the knowledge and skills of a Category II Vibration Analyst and be able to provide technical knowledge and instruction to lower level analysts. A Category III Vibration Analyst shall have an in-depth knowledge of the principles and techniques machinery vibration analysis including single channel spectra, time waveforms, orbits, basic operating deflection shapes, and acceleration enveloping. They shall be qualified to design, direct, and manage routine condition monitoring programs, to conduct non-routine fault analyses, and to understand and direct alternative condition monitoring technologies to investigate and verify issues not resolved by vibration analysis. The Analyst shall be able to direct machinery corrective actions including rotor balancing and to recommend restrictions in machine operation.

CATEGORY IV CERTIFIED VIBRATION ANALYSTS

...shall have all the knowledge and skills of a Category III Vibration Analyst and in-depth knowledge, skills, and experience in the diagnosis and correction of machine faults using basic mechanical vibration theory, signal analysis, multi-channel spectral analysis, rotor and gas pulsation dynamics, and isolation and damping techniques. They shall be able to apply parameter identification techniques to determine natural frequencies, mode shapes, damping, and operating deflection shapes; to conduct two-plane balancing; to recommend machine mounting corrective actions including design modifications, resilient mounting, and foundation re-design; and to interpret published codes and standards.

A table showing the basic subject and topics required for each category of certification is included in this Handbook. For more detail on the Body of Knowledge, see ISO 18436-2:2014. Note: The Standard is a copyright of ISO and thus must be purchased from them.

SURVEILLANCE

The Vibration Institute randomly conducts surveillance of exams and proctors to ensure that proper procedures have been followed. The Institute also conducts surveillance when a potential issue is suspected.

CHEATING AND FORGERY

The Vibration Institute will not tolerate cheating of any kind, Forgery of Certificates or violations of the Code of Ethics www.vi-institute.org/code-of-ethics/ (view here or reference page 29). Anyone caught cheating, evolved in collusion, engaged in forgery of certificates, or violating the Code of Ethics will have one or more of the following sanctions levied on them: exam disqualified, certification revoked, banned on retaking a certification exam for some period of time.

RECOMMENDATIONS AND REQUIREMENTS FOR CERTIFICATION

It is important that candidates have a combination of education, training, and experience so that they understand the principles and procedures of machinery vibration monitoring and diagnostics. Recommendations and requirements covered in ISO 18436-2 are briefly reviewed in this section.

EDUCATION

There is no formal education requirement for sitting for any certification exam per ISO 18436-2, however, candidates are expected to be able to manipulate simple algebraic equations, use a basic scientific calculator, and be computer literate. It is recommended that candidates for Category I and Category II have a minimum high school education, and candidates for Category III and Category IV have minimum 2-year degree in mechanical engineering technology.

TRAINING HOURS

To be eligible to sit for (take) a certification examination applicants shall provide evidence of the successful completion of formal training (provided by a training body that conforms to the requirements of ISO 18436-3), which has been based on the Body of Knowledge for each category (view here or reference page 16). Training should take the form of formal lectures, demonstrations, trainer-specified practical exercises, and/or distance-controlled self-study (e.g., correspondence courses).

In order for controlled self-study to qualify as training hours and per ISO 18436-3 “Requirements for training bodies and the training process”, for any distance training/self-study, it is recommended that the candidate be assessed by the trainer or training organization to verify experience. Additionally, ISO 18436-3 requires that candidates take a closed book training examination, formulas sheets may be permitted, and upon completion, the trainer must provide a score and a written summary of the results.

It is required that training time meet the minimums in Table 1 below:

Table 1 – Minimum Required Training Hours

Category I	Category II	Category III	Category IV
30 hours	Category I + 38 hours	Category II + 38 hours	Category III + 64 hours

Sources of technological information are listed in the Sources for Self-Study and Review on page 15 in this Handbook.

ADDITIONAL TRAINING

ISO 18432-2 recommends but does not require additional training on machine knowledge. It recommends machinery and component training, or equivalent on the job training of at least ½ the duration of the required training. This is important training that should be considered seriously by the candidate. The Vibration Institute does include exam questions related to machinery knowledge.

EXPERIENCE

To be eligible to sit for an exam, candidates shall provide evidence of experience in the field of machinery vibration condition monitoring and diagnostics. For category IV candidates, validation may be acquired from another category IV practitioner or their company manager. The minimum required experience can be found in Table 2 below:

Table 2 – Minimum Required Experience in Months

Category I	Category II	Category III	Category IV
6	18	36	60

MATURE ("DIRECT") ENTRY TO CATEGORY II & III

Mature Entry to Category II: A certification candidate may skip the Vibration Institute Category I examination, certification, and formal training requirements for Category I, and apply directly for Category II certification if they meet any one of the following criteria. Candidates must still meet the 38-hour training requirement for Category II and one of the following criteria:

- Has a 4-year degree from a college or university plus 12 months experience
- Has a 2-year technical degree from a college or university plus 12 months experience
- Has 3 or more years of work experience in vibration analysis

Mature Entry to Category III: A certification candidate may skip the Vibration Institute Category II examination, certification, and formal training requirements for Category II, and apply directly for Category III certification if they meet any one of the following criteria. Candidates must still meet the 38-hour training requirement for Category III and one of the following criteria:

- Has a 4-year degree from a college or university plus 5 years experience
- Has a 2-year technical degree from a college or university plus 6 years experience
- Has 7 or more years of work experience in vibration analysis

CERTIFICATION EXAMINATIONS

Candidates are required to answer a number of multiple-choice questions based on the job descriptions in Section 4 of ISO 18436-2, the subject and topics in Annex A of ISO 18436-2, and machinery knowledge as described in Section 5.3.2 of ISO 18436-2 as deemed necessary by the Institute's Certification Committee. The topics are summarized for each category in the Body of Knowledge stated on page 16 in this Handbook, however, it is not a substitute for ISO 18466-2, which is available from ISO. Exam items (questions) are of a practical nature and cover the concepts, principles, and applications necessary to conduct machinery vibration measurements. Mathematical calculations are required, as is a capability to interpret tables, plots, and charts as given in the sample questions beginning on page 30 in this Handbook.

Table 3 – Exam Details by Category

	Number of Questions on Exam	Time Allowed to Complete Exam
Category I	63	2 hours
Category II	105	3 hours
Category III	105	4 hours
Category IV	63	5 hours

All Institute examinations contain questions for beta testing. These extra questions (one per 20 examination questions) are present on all certification examinations and are unknown to the candidate.

Pertinent equations are supplied for the closed-book examinations and reference materials are not permitted in the examination room. All calculations must be completed on the examination. It is recommended that candidates bring both pens and #2 pencils (HB lead) to the examination. For exams that use a bubble style answer sheet (i.e., pencil in the rectangle corresponding to the selected answer), a #2 pencil is required. A basic scientific calculator is required for Category II, III, & IV exams and is recommended for Category I. The calculator cannot be programmable, have text editing capability, or have any communication capability whatsoever. Smartphones cannot be used.

For detailed instructions, contact the Vibration Institute at (630) 654-2254 or review the information on the Institute's website at www.vi-institute.org.

EXAMINATION DEVELOPMENT

The Vibration Institute Scheme Committee utilizes normally accepted psychometric methods to develop fair, valid and reliable examinations that assess the qualifications of candidates to determine if they meet the minimum requirements for certification at a given category. These methods include intense review of all items (questions) for category selection, difficulty, topic applicability, readability, validity, reliability, and cognitive levels. Examination item statistics are monitored to verify their difficulty and effectiveness. Any item that does not meet Vibration Institute minimum statistical requirements are retired or reworked. Examinations are evaluated by the Certification Committee, subject matter experts, to determine cut score (minimum passing score) that reflect the minimum knowledge to pass a given Category examination.

Please note that all candidates who score the minimum or higher score receive the same Certificate; therefore, the actual score received, other than being above the minimum, has no bearing on receipt of a Certificate. The Institute follows ISO 18436-1 which prohibits the release of any examination scores.

DATES AND LOCATIONS

Examinations for Vibration Analyst in categories I-IV are scheduled the day following Vibration Institute training courses, at the Vibration Institute Annual Training Conference (VIATC), and at various other sites during the year. An examination schedule and an "Application for Examination and Certification of Vibration Analysts per ISO 18436-2:2014" (VI Form CF009) is available from the Vibration Institute office and online at www.vi-institute.org.

SCORING

In order to have a valid and reliable exam, the cut score (i.e., minimum passing score) cannot be set arbitrarily. Some organizations arbitrarily set the cut score at 70% just because the example in ISO 18436-2 uses this number, however, this is not a valid way of setting a cut score and, more importantly, is not defensible. Vibration Institute cut scores are determined by the Scheme Committee along with a psychometrician using the widely accepted Angoff Method. Thus, the passing score varies somewhat from exam to exam based on the difficulty of the items that make up the exam.

RE-EXAMINATION

A candidate who fails to obtain the passing grade required for recognition (certification) may be re-examined twice, provided that the re-examinations take place not sooner than 30 days after the previous examination and within 1-year of the previous examination. A candidate who fails three consecutive attempts shall be excluded from reassessment for 12 months. Such a candidate shall be required to reapply as a new candidate. If the candidate fails a 4th time, they must wait a minimum of 12 months before reapplying and must also take a relevant vibration class with a minimum duration of 24 class hours. Candidates that subsequently failure at the same category are required to repeat the requirements for a 4th failure.

Candidates who have their certification revoked for reasons of unethical behavior as described in part in the CHEATING and FORGERY section of this Handbook must wait a minimum of 12 months and possibly longer,

depending on the situation, before applying for reexamination. In severe cases of repeated cheating and forgery, the candidate may be banned from taking another certification exam permanently.

It is highly recommended that candidates who want to retest contact the Vibration Institute and request an Exam Review if they have not already done so.

EXAM REVIEWS

Individuals who fail a certification examination may fill out a "Request for Examination Review" found on the Vibration Institute website and request a written review of their examination within five years of the test date. The applicant will be provided with a study guide relative to their performance on the examination that indicates the subject and topic areas requiring additional study. Please note that absolute scores cannot be provided.

COMPLAINTS AND APPEALS

Any examinee, candidate, certificant or individual may file a complaint or appeal in accordance with Vibration Institute certification procedure "Complaints and Appeals" (CP011). A complaint may involve the Institute's certification program or a certified individual. Appeals may involve the decision on disqualification, certification, or recertification.

Persons denied certification or disqualified for reasons of expiration, failure of examination, cheating, or other such reasons, may make written appeal using "Complaint or Appeal Form" (CF021) found on the Vibration Institute website under the certification section. Complaints and appeals will be reviewed confidentially and impartially. The reviewing authority reviews all available evidence and comes to a judgment in a fair and impartial manner.

- Appeals of failing an exam are reviewed by the Appeals Committee.
- Appeals for recertification by points denial are reviewed by the Technical Director of Certification.
- Appeals on exam items (questions) and/or supplied equations (suspected errors by the examinee) are reviewed by the Appeals Committee.
- Appeals on disqualification are reviewed by the Executive Director and Technical Director of Certification.
- Procedural complaints are reviewed by the Executive Director and Technical Director of Certification.
- Complaints regarding proctors or staff are reviewed by the Executive Director and Technical Director of Certification.

Any complaint or appeal ruling made by the Executive Director, Technical Director of Certification, or Appeals Committee can be appealed to the Vibration Institute Board of Directors in writing (email, letter, or fax). The Board of Directors will provide a decision to grant or deny the appeal based on the facts. Any decision made by the Vibration Institute Board of Directors is final.

Any complaint or appeal will be responded to within 90 of the receipt of the "Complaint or Appeal Form" (CF021).

If the complaint is about a Vibration Institute certified individual, the certified individual will be notified by the Vibration Institute of the complaint lodged against them and given an opportunity to respond to the allegations.

If you have any questions about the Vibration Institute's Complaint and Appeals process, please contact the Vibration Institute Executive Director, Michael Long, CAE at mlong@vi-institute.org or by phone at 630-654-2254.

WITHDRAWALS

Certified individuals may resign their status by letter or by not completing the recertification process.

SOURCES FOR SELF-STUDY AND REVIEW

CATEGORY I

- Introduction to Machinery Vibrations, R.L. Eshleman, Vibration Institute (2009).**
- Vibration Monitoring Handbook, C.W. Reeves, Coxmoor Publishing (1998).

CATEGORY II

- Basic Machinery Vibrations, R.L. Eshleman, VI Press (1999).**
- Basic Technical Mathematics with Calculus, 10th edition, A.J. Washington, Pearson, Boston (2013).

CATEGORY III

- Machinery Vibration Analysis, R.L. Eshleman, Vibration Institute (2002). **
- The Simplified Handbook of Vibration Analysis, Vol. I, A.R. Crawford & S. Crawford, Computational Systems, Inc. (1992).
- The Bearing Analysis Handbook, J.I. Taylor & D. W. Kirkland, Vibration Consultants, Inc. (2004).
- Balancing of Rotating Machinery, R.L. Eshleman, Vibration Institute (2005).**
- The Gear Analysis Handbook, J.I. Taylor, Vibration Consultants, Inc. (2000).

CATEGORY IV

- Advanced Vibration Analysis, N.L. Baxter, J.L. Frarey, and R. Kelm, Vibration Institute (2010).**
- Advanced Vibration Control, Vibration Institute (2011).**
- Harris' Shock and Vibration Handbook, 6th Edition, A.G. Piersol and T. L. Paez, McGraw-Hill (2010).
- Rotor Dynamics and Modeling notes, Vibration Institute (2012).**
- Rotating Machinery Vibration, 2nd Edition, M.L. Adams, Jr., Marcel Dekker, Inc. (2010).
- Vibration Testing: Theory and Practice, 2nd Edition, K.G. McConnell, John Wiley & Sons (1995).
- Theory of Vibration with Applications, 5th Edition, W.T. Thomson & M.D. Dahleh, Pearson/Prentice Hall (1998).
- Vibration-based Condition Monitoring, Robert Bond Randall, Wiley (2011).
- Vibration Monitoring, Testing, and Instrumentation, C. de Silvia, CRC Press (2007).

***All of these sources are available from the Vibration Institute.**

**** Only available through Vibration Institute training/correspondence course registration.**

BODY OF KNOWLEDGE

SUBJECT	CATEGORY			
1. Vibration Principles:	**I**	**II**	**III**	**IV**
Basic motion	X	X	X	
Period, frequency	X	X	X	
Amplitude (Peak, peal-to-peak, RMS)	X	X	X	
Parameters (Displacement, velocity, acceleration)	X	X	X	
Units, unit conversions	X	X	X	
Time and frequency domains	X	X	X	
Vectors, modulation			X	X
Phase		X	X	X
Natural frequency, resonance, critical speeds	X	X	X	X
Force, response, damping, stiffness			X	X
Instabilities, non-linear systems				X
2. Data Acquisition:	**I**	**II**	**III**	**IV**
Instrumentation	X	X	X	X
Dynamic range, signal to noise ratio			X	X

SUBJECT	CATEGORY			
Transducers	X	X	X	
Sensor mounting, mounted natural frequency	X	X	X	
Fmax acquisition time		X	X	
Proximity sensor conventions		X	X	
Triggering		X	X	
Test planning		X	X	X
Test procedures	X	X	X	X
Data formats		X	X	
Computer database upload/download	X			
Recognition of poor data	X	X	X	
3. Signal Processing:	**I**	**II**	**III**	**IV**
RMS/peak detection				X
Analogue/digital conversion				X
Analogue recording and digital sampling		X	X	X
FFT computation			X	X
FFT application	X	X		

SUBJECT	CATEGORY			
Time windows (Uniform, Hanning, flat-top)		X	X	
Filters (Low pass, high pass, band pass, tracking)		X	X	X
Anti-aliasing		X	X	X
Bandwidth, resolution		X	X	X
Noise reduction		X	X	X
Averaging (Linear, synchronous time, exponential)		X	X	X
Dynamic range		X	X	X
Signal to noise ratio				X
Spectral maps			X	X
4. Condition Monitoring:	**I**	**II**	**III**	**IV**
Computer database set-up and maintenance			X	
Equipment evaluation and prioritization		X		
Monitoring program design		X	X	X
Alarm set-up (Narrowband, envelope)			X	
Baseline assessments, trending		X	X	
Route planning		X	X	

SUBJECT	CATEGORY			
Alternate technologies (e.g. oil analysis, wear debris analysis, infrared thermography, motor current analysis, acoustic emission)			X	X
Fault condition recognition	X	X		
5. Fault Analysis:	**I**	**II**	**III**	**IV**
Spectrum analysis harmonics and sidebands		X	X	X
Time waveform analysis		X	X	X
Phase analysis		X	X	X
Transient analysis			X	X
Orbital analysis			X	X
Shaft center-line analysis		X	X	X
Enveloping		X	X	X
Mass unbalance		X	X	
Misalignment		X	X	
Mechanical looseness		X	X	
Rubs, instabilities			X	X
Bearing defects (Rolling element, journal)		X	X	

SUBJECT	CATEGORY			
Electric motor defects		X	X	X
Flow induced vibration, aerodynamics and liquids			X	X
Gearbox analysis		X	X	
Resonance and critical speeds		X	X	X
Turbomachinery			X	X
General fault recognition	X			
6. Corrective Action:	**I**	**II**	**III**	**IV**
Shaft alignment		X	X	
Field balancing		X	X	X
Replacement of machine parts			X	
Flow control			X	X
Isolation and damping			X	X
Resonance control			X	X
Basic maintenance action	X	X	X	
7. Equipment Knowledge:	**I**	**II**	**III**	**IV**
Electric motors, generators and drives	X	X	X	

SUBJECT	CATEGORY			
Pumps, fans	X	X	X	
Steam turbines, gas turbines		X	X	
Compressors	X	X	X	
Reciprocating machinery		X	X	
Rolling mills, paper machines, other process equipment	X	X	X	
Machine tools	X	X	X	
Structures, piping	X	X	X	
Gearboxes	X	X	X	
Rolling element bearings		X	X	
Journal bearings		X	X	
Gearing		X	X	
Couplings, belts		X	X	
8. Acceptance Testing:	**I**	**II**	**III**	**IV**
Test procedure	X	X		
Specifications and standards		X	X	
Reporting		X	X	

SUBJECT	CATEGORY			
9. Equipment Testing and Diagnostics:	**I**	**II**	**III**	**IV**
Impact testing		X	X	X
Forced response testing		X	X	X
Transient analysis			X	X
Transfer functions			X	X
Damping evaluation				X
Cross channel phase			X	X
Operating deflection shapes			X	X
Modal analysis			X	X
Torsional vibration				X
10. Reference Standards	**I**	**II**	**III**	**IV**
ISO		X	X	X
IEC		X	X	X
Relevant national standards		X	X	X
11. Reporting and Documentation:	**I**	**II**	**III**	**IV**
Condition monitoring reports		X	X	

SUBJECT	CATEGORY			
Vibration diagnostic reports		X	X	X
12. Fault Severity Determination:	**I**	**II**	**III**	**IV**
Spectrum analysis		X	X	X
Time waveform analysis, orbit analysis		X	X	X
Levels: overall, narrowband, component		X	X	
Severity charts: graphs and formula		X	X	X
13. Rotor/Bearing Dynamics:	**I**	**II**	**III**	**IV**
Rotor characteristics				X
Bearing characteristics				X
Rotor balancing				X

APPLICABLE ISO STANDARDS

ISO REFERENCE	CATEGORY			
	I	II	III	IV
ISO 1925, Mechanical vibration – Balancing – Vocabulary		X	X	X
ISO 1940-1, Mechanical vibration – Balance quality requirements of rigid rotors – Part 1; Specification and verification of balance tolerances		X	X	X
ISO 2017-1, Mechanical vibration and shock – Resilient mounting systems – Part 1: Technical information to be exchanged for the application of isolation systems				X
ISO 2041, Mechanical vibration, shock and condition monitoring – Vocabulary		X	X	X
ISO 2954, Mechanical vibration of rotating and reciprocating machinery – Requirements for instruments for measuring vibration severity				X
ISO 5348, Mechanical vibration and shock – Mechanical mounting of accelerometers		X	X	X
ISO 7919-1, Mechanical vibration of reciprocating machines – Measurement on rotating shafts and evaluation criteria – Part 1: General guidelines	X	X	X	X
ISO 7919-2, Mechanical vibration – Evaluation of machine vibration by measurements on rotating shafts – Part 2: Land-based steam turbines and generators in excess of 50 MW with normal operating speeds of 1500r/min, 1800r/min, 3000 r/min and 3600 r/min		X	X	X

ISO REFERENCE	CATEGORY			
	I	II	III	IV
ISO 7919-3, Mechanical vibration – Evaluation of machine vibration by measurements on rotating shafts – Part 3: Coupled industrial machines		X	X	X
ISO 7919-4, Mechanical vibration – Evaluation of machine vibration by measurements on rotating shafts – Part 4: Gas turbines with fluid-film bearings		X	X	X
ISO 7919-5, Mechanical vibration – Evaluation of machine vibration by measurements on rotating shafts – Part 5: Machine sets in hydraulic power generating and pumping plants		X	X	X
ISO 8528-9, Reciprocating internal combustion engine driven alternating current generating sets – Part 9: Measurement and evaluation of mechanical vibrations		X	X	X
ISO 8569, Mechanical vibration and shock – Measurement and evaluation of shock and vibration effects on sensitive equipment in buildings			X	X
ISO 10816-1, Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 1: General guidelines	X	X	X	X
ISO 10816-2, Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 2: Land-based steam turbines and generators in excess of 50 MW with normal operating speeds of 1500r/min, 1800r/min, 3000 r/ min and 3600 r/min		X	X	X

ISO REFERENCE	CATEGORY			
	I	II	III	IV
ISO 10816-3, Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 3: Industrial machines with nominal power above 15kW and nominal speeds between 120 r/min and 15000 r/min when measured in situ		X	X	X
ISO 10816-4, Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 4: Gas turbine sets with fluid-film bearings		X	X	X
ISO 10816-5, Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 5: Machine sets in hydraulic power generating and pumping plants		X	X	X
ISO 10816-6, Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 6: Reciprocating machines with power ratings above 100 kW		X	X	X
ISO 10816-7, Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts – Part 7: Rotordynamic pumps for industrial applications, including measurements on rotating shafts		X	X	X
ISO 10817-1, Rotating shaft vibration measuring systems – Part 1: Relative and absolute sensing of radial vibration			X	X
ISO 11342, Mechanical vibration – Methods and criteria for the mechanical balancing of flexible rotors				X
ISO 13372, Condition monitoring and diagnostics of machines – Vocabulary	X	X	X	X

ISO REFERENCE	CATEGORY			
	I	II	III	IV
ISO 13373-1, Condition monitoring and diagnostics of machines – Vibration condition monitoring – Part 1: General procedures	X	X	X	X
ISO 13373-2, Condition monitoring and diagnostics of machines – Vibration condition monitoring – Part 2: Processing, analysis and presentation of vibration data		X	X	X
ISO 13374-1, Condition monitoring and diagnostics of machines – Data processing, communication and presentation – Part 1: General guidelines		X	X	X
ISO 13379-1. Condition monitoring and diagnostics of machines – Data interpretation and diagnostics techniques – Part 1: General guidelines			X	X
ISO 13381-1, Condition monitoring and diagnostics of machines – Prognostics – Part 1: General guidelines		X	X	X
ISO 14694, Industrial Fans – Specifications for balance quality and vibration levels	X	X	X	X
ISO 14695, Industrial fans – Method of measurement of fan vibration			X	X

ISO REFERENCE	CATEGORY			
	I	II	III	IV
ISO 17359, Condition monitoring and diagnostics of machines – General guidelines	X	X	X	X
ISO 18431-1, Mechanical vibration and shock – Signal processing – Part 1: General introduction		X	X	X
ISO 18431-2, Mechanical vibration and shock – Signal processing – Part 2: Time domain windows for Fourier Transform analysis		X	X	X
ISO 18436-1, Condition monitoring and diagnostics of machines – Requirement for qualification and assessment of personnel – Part 1: Requirements for assessment bodies and the assessment process				X
ISO 18436-3, Condition monitoring and diagnostics of machines – Requirement for qualification and assessment of personnel – Part 3: Requirements for training bodies and the training process				X
ISO 19499, Mechanical vibration – Balancing – Guidance on the use and application of balancing standards				X
ISO 21940-13, Mechanical vibration – Rotor balancing – Part 13: Criteria and safeguards for the in-situ balancing of medium and large rotors				X
ISO 21940-14, Mechanical vibration – Rotor balancing – Part 14: Procedures for assessing balance errors			X	X

CODE OF ETHICS

Individuals certified according to the Vibration Institute's Vibration Analyst scheme must recognize the precepts of personal integrity and professional competence as international principles.

Accordingly, certified individuals shall:

I. perform their professional duties with proper regard for the physical environment and the safety, health and well-being of the public;

II. undertake only those vibration tasks for which they are competent by virtue of their training and experience, and where warranted, engage or advise the engagement of such analysts as are required to enable them to properly complete assignments;

III. conduct themselves in a responsible manner and utilize fair and equitable business practices in dealing with colleagues, clients and associates;

IV. protect to the fullest extent possible, consistent with the well-being of the public, any information given them in confidence by an employer, colleague or member of the public;

V. refrain from making unjustified statement or from performing unethical acts which would discredit the certification program based on this scheme;

VI. indicate to the employer or client any adverse consequences which may result from an over-ruling of the technical judgment by a non-technical authority;

VII. avoid conflicts of interest with any employer or client, and if any such conflicts should arise in the performance of work inform the affected persons promptly of the circumstances;

VIII. strive to maintain their proficiency by updating the technical knowledge as required to properly perform condition monitoring and diagnostics measurement and analysis techniques; and

IX. refrain from misuse of the Institute's logo and certification status.

X. inform the Vibration Institute, without delay, of matters that can affect the capability of the certified person to continue to fulfill the certification requirements. Failure to do so may result in forfeiture of your certificate.

SAMPLE QUESTIONS

IMPORTANT- You must bring pens, #2 pencils (HB lead), and a basic scientific calculator to the examination. For more details, visit the Vibration Institute Certification Examination Process page at https://www.vi-institute.org/vibration-institute-examination-process/ or contact the Vibration Institute.

CATEGORY I SAMPLE QUESTIONS

1. **What are the units of vibration velocity?**

    a. Mils
    b. G's
    c. inches per second
    d. Inches

2. **The period of vibration is typically measured in**

    a. Days.
    b. Minutes.
    c. Milliseconds.
    d. Nanoseconds.

3. **A vibration transducer used to evaluate pump faults and condition should be mounted**

    a. Anywhere.
    b. on the floor.
    c. close to the machine bearings.
    d. on the piping.

4. **In vibration work the Fast Fourier Transform is used to**

    a. obtain the amount of vibration at machine frequencies.
    b. transform machine vibration into heat.
    c. generate a vibration waveform.
    d. filter out unwanted noise from the data.

5. **Baseline vibration measurements are made to**

    a. evaluate the life of equipment.
    b. generate new design information.
    c. provide a basis for future comparisons of data.
    d. evaluate instruments used for monitoring.

6. A gearbox can be used in a machine train to

a. increase vibration surveillance.
b. lower vibration levels.
c. reduce heat.
d. allow driven and driver to operate at different speeds.

7. A 60 Hz two-pole induction motor operates

a. at 3,600 RPM under load.
b. at a speed less than its magnetic frequency.
c. with no slip.
d. at 7,200 RPM.

8. The principal function of acceptance testing is to obtain

a. equipment that meets a specification.
b. baseline data.
c. a fault analysis.
d. a condition evaluation.

9. The vibration level on a fan increased from 0.1 inch per second to 1.0 inch per second over the period of a month. What is the possible cause of the increase in vibration?

a. loss of a blade
b. small rolling element bearing defect
c. change in the weather
d. change in operational conditions

10. Operation of a machine at its critical speed

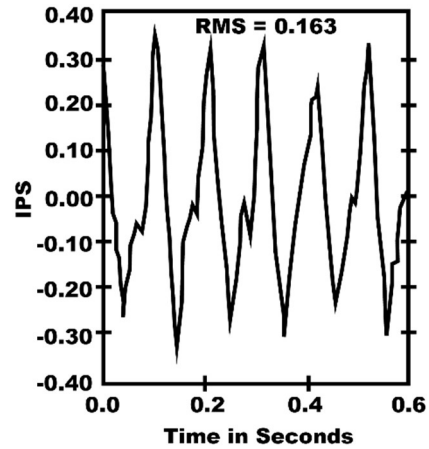
a. may cause decreased vibration levels.
b. may not change the vibration levels.
c. may increase vibration levels.
d. will increase its efficiency.

ANSWERS TO SAMPLE QUESTIONS FOR CATEGORY I:

1. c, 2. c, 3. c, 4. a, 5. c, 6. d, 7. b, 8. a, 9. a, 10. C

CATEGORY II SAMPLE QUESTIONS

FIGURE 1



1. **What is the fundamental frequency of the waveform shown in Figure 1?**

   a. 5.3 Hz
   b. 9.52 Hz
   c. 22.8 Hz
   d. 60 CPM

2. **What measure has been shown to be most effective for evaluation of general machine condition from bearing cap measurements?**

   a. Displacement
   b. Acceleration
   c. mils
   d. Velocity

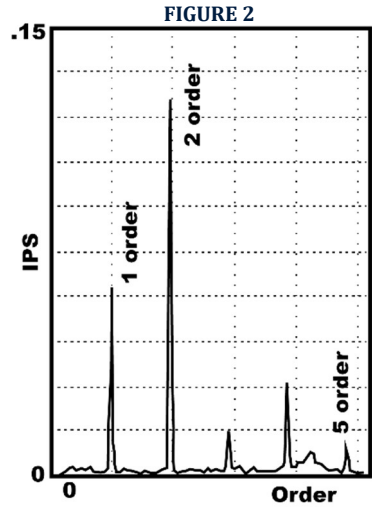
3. **What is the most basic display that can be used to directly determine the phase relationship between the vibrations measured at two locations on a machine?**

   a. amplitude vs. frequency
   b. polar plot
   c. Bodé plot
   d. time waveform

4. **What is the peak amplitude of the waveform shown in Figure 1?**

   a. 0.23 IPS
   b. 0.70 IPS
   c. 0.12 g's
   d. 0.35 IPS

FIGURE 2



5. **The data shown in Figure 2 were taken off the inboard bearing of a two-pole motor in the horizontal direction. The spectrum of the axial vibration contains a component at 3,580 CPM equal to 0.2 in./sec. What is the most likely fault?**

   a. mass unbalance
   b. Misalignment
   c. air-gap variation
   d. Looseness

6. **The frequency span used for fault analysis on an FFT analyzer is concerned with**

   a. dynamic range.
   b. phase distortion.
   c. Resolution.
   d. Amplitude.

7. **Vibration from rotor mass unbalance appears in the spectrum at a frequency of**

    a. 3 times operating speed.
    b. 4.5 times operating speed.
    c. one times operating speed.
    d. 0.5 times operating speed.

8. **Calculate the gear-mesh frequency for a gear set with 28 pinion teeth and 99 gear teeth. The pinion operates at 1,776 RPM.**

    a. 500 Hz
    b. 30,000 CPM
    c. 49,728 CPM
    d. 175,824 CPM

9. **An accelerometer was used to measure 2 g's peak at 565 Hz. What was the peak vibration velocity?**

    a. 0.2 mil
    b. 2 mils
    c. 0.02 inch/second
    d. 0.22 inch/second

10. **The first alarm or alert is set on a data collector to initiate**

    a. a fault analysis.
    b. a time-to-failure calculation.
    c. a reduction in the alarm setting.
    d. machine shutdown.

ANSWERS TO SAMPLE QUESTIONS FOR CATEGORY II:

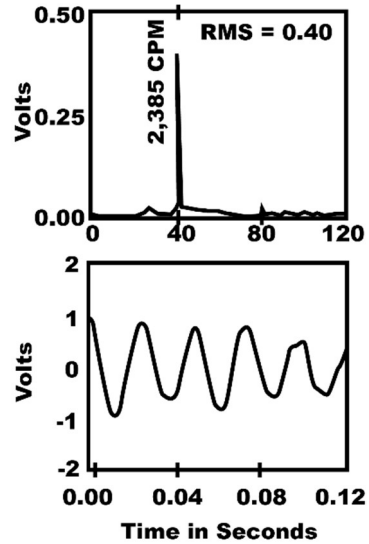
1. b, 2. d, 3. d, 4 d, 5. b, 6. c, 7. c, 8. c, 9. d, 10. A

CATEGORY III SAMPLE QUESTIONS

1. **The data shown in Figure 3 were acquired from a vertical pump bearing in the horizontal direction with an accelerometer integrated to velocity - 1,000 mv/in./sec. What is the peak vibration in in./sec?**

   a. 0.110
   b. 0.398
   c. 0.578
   d. 1.0

FIGURE 3



2. **Spectrum analysis of a motor-driven gearbox with sleeve bearings, an input speed of 3,585 RPM, and a pinion containing 73 teeth would require which of the following transducer mounting techniques?**

   a. handheld
   b. Magnet
   c. Wax
   d. Stud

3. **A 1,785 RPM-200 HP motor drives a hammer mill through a fluid coupling at 1,720 RPM. If a maximum number of 800 lines of resolution are available on an FFT spectrum analyzer and a Hanning window is used, what is the maximum frequency span that will permit resolution of the operating speed components of the motor and hammer mill?**

   a. 300,000 CPM
   b. 120,000 CPM
   c. 60,000 CPM
   d. 17,333 CPM

4. **A polar plot typically contains data from a permanently-mounted proximity probe. What information is obtained from the polar plot on start-up?**

   a. bearing stiffness
   b. critical speeds
   c. rotor mass
   d. oil viscosity

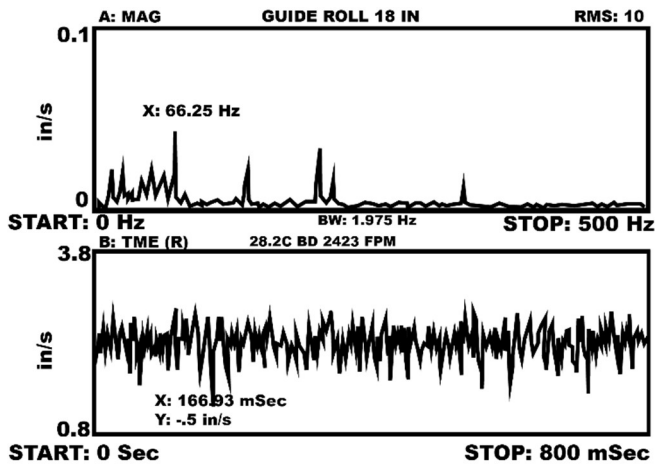
5. **A 400 pound rotor is being balanced in place at 1,775 RPM. The initial vibration reading measured with a non-contacting displacement transducer was 3 mils at 155º. The rotor showed a critical speed at 1,250 RPM on coast down. What should be the size and location of the trial weight if it is mounted at a radius of 10 inches?**

    a. 0.72 oz - 335º
    b. 0.72 oz - 155º
    c. 0.50 oz - 155º
    d. 0.35 oz - 245º

6. **The vibration data shown in Figure 4 were taken from the pedestal of an 18-inch diameter guide roll with a surface speed of 2,473 ft/min. The roll is supported on rolling element bearings with the following defect frequencies: BPFO, 5.24 x RPM; BPFI 7.57 x RPM; BSF, 2.41 x RPM; FTF, 0.4 x RPM. What is the vibration source?**

    a. pedestal looseness
    b. mass unbalance
    c. bearings defect(s) on outer race
    d. bearing defect(s) on inner race

FIGURE 4



7. **What is the likely cause of the excessive vibration measured on the vertical pump from Figure 3? An impact test showed a structural natural frequency at 39.5 Hz.**

    a. mass unbalance
    b. Resonance
    c. Misalignment
    d. Cavitation

8. **Vibration measured on a two-pole motor in the horizontal direction shows 0.1 IPS and 0.02 IPS at 1x and 2x operating speed respectively. At. 7,200 CPM the motor has a component of 0.25 IPS in the same spectrum. What is the major source of the excessive vibration?**

    a. mass unbalance
    b. Misalignment
    c. Looseness
    d. casing distortion

9. **A spectrum containing data from a single-reduction gearbox includes vibration activity at gear speed (0.05 IPS at 59.5 Hz) and gear mesh frequencies (0.5 IPS at 5,950.0 Hz). What is the dynamic range of the analyzer required if the data are to be shown in an acceleration spectrum?**

    a. 6 dB
    b. 12 dB
    c. 40 dB
    d. 60 dB

10. A blower operating at 1,785 RPM has a large component of vibration (0.35 in./sec) at operating speed. An impact test shows a structural natural frequency of the support frame at 1,800 CPM. What would be the best corrective action to reduce the blower vibration?

a. balance the blower
b. stiffen the support frame
c. reduce the stiffness of the support frame
d. align the blower to the motor

ANSWERS TO SAMPLE QUESTIONS FOR CATEGORY III:

1. d, 2. d, 3. d, 4. b, 5. b, 6. d, 7. b, 8. d, 9. d, 10. B

CATEGORY IV SAMPLE QUESTIONS

1. **If you are using a 12-bit analog-to-digital converter with a full-scale range of ± 5 volts, what is the minimum peak amplitude of a sine wave that can be detected?**

   a. 9.76 mv
   b. 4.88 mv
   c. 2.44 mv
   d. 1.44 mv

2. **Determine the damped natural frequency and percentage of critical damping from the impact test data shown in Figure 5.**

   a. 46 Hz, 50%
   b. 30.8 Hz, 50%
   c. 30.8 Hz, 48%
   d. 30.8 Hz, 11%

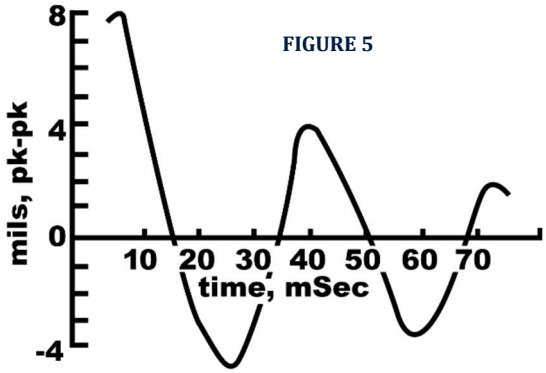


FIGURE 5

3. **The original vibration of a counter clockwise rotating fan was 7.0 mils @40°. After a four (4) oz. trial weight was attached at 60° the vibration reading was 5 mils @ 120°. What is the balance sensitivity and phase lag of the high spot to the heavy spot?**

   a. 1.0 oz./mil @ 180°
   b. 0.5 oz./mil @ 120°
   c. 0.25 oz./mil @ 60°
   d. 0.5 oz./mil @ 300°

4. **A 1,000 pound 4-pole induction motor is to be mounted on four isolators to minimize vibration transmitted to its foundation. Which isolator would be preferred in the installation?**

   a. rubber mount, c/cc = 0.3, kh = 25,000 lb/in., kv = 30,000 lb/in.
   b. leaf spring, c/cc = 0.025, kh = 50,000 lb/in., kv = 100,000 lb/in.
   c. spring mount, c/cc = 0.01, kh = 1,800 lb/in., kv = 2,500 lb/in.
   d. neoprene mount, c/cc = 0.02, kh = 500 lb/in., kv = 250 lb/in.

5. **All rotor-bearing instability mechanisms have in common**

   a. low damping in the axial plane of the rotor.
   b. a destabilizing tangential force normal to the rotor radial vibration.
   c. a stiffness that exceeds the force in the rotor radial direction.
   d. an eigenvalue that is always imaginary.

6. **A center-mounted fan that operates at 1,185 RPM is supported on rolling element bearings with a stiffness of 50,000 lb/in each. The impeller, which weighs 1,000 pounds, is supported on a four-inch diameter shaft with a center-to-center bearing span of 100 inches. What vibration amplitude can be expected if the fan is balanced to 3.2 in.-oz? (Neglect shaft weight & damping; E= 30E06 lb/in^2)**

    a. 0.65 mil - peak to peak
    b. 1.2 mils - peak to peak
    c. 2.1 mils - peak to peak
    d. 0.02 IPS

7. **When an impact test is performed, a force window is used to**

    a. amplify the level of the force pulse.
    b. zero out noise after the force pulse.
    c. make the response decay within the restraints of the sample window.
    d. broaden the frequency range of the pulse.

8. **An important test was conducted on a machine frame made with bolted joints using an instrumented hammer and an accelerometer. If the accelerometer signal is single integrated, what possible spectral display can be obtained?**

    a. Mobility
    b. Accelerance
    c. apparent mass
    d. dynamic stiffness

9. **A rotor-bearing system that has split critical speeds, half critical speeds, and zones of instability must have**

    a. couple unbalance.
    b. non-symmetric rotor stiffness.
    c. non-symmetric bearing stiffness.
    d. bi-linear rotor damping.

10. **A 3200 line, 800 Hz spectrum display includes the following peak components-- 0.5 gs @100Hz, 2 gs @200 Hz, 3.5 gs @ 250 Hz, and 0.5 gs @ 500 Hz. What is the digital rms value of the signal in gs?**

    a. 6.5
    b. 5.25
    c. 4.09
    d. 2.89

ANSWERS TO SAMPLE QUESTIONS FOR CATEGORY IV:

1. c, 2. d, 3. b, 4. c, 5. b, 6. a, 7. b, 8. a, 9. b,10. d.

Vibration Institute

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