APPTRONICS review

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From the HoD's desk

Dear Reader,

Yet another semester is getting over. After 3 months of rigorous classes, study holidays have started and you are preparing for the exams.

Engineers have to be thorough with the concepts. Importance should be given to understanding the underlying concepts, and associating the concepts with practical scenarios rather than trying to memorize facts. Therefore, objective behind learning a topic should be well understood.

Here are a few points that you could keep in mind while appearing for the exam.

· Time management

Allot time for each question based on the corresponding marks. Remember to allot some 'buffer' time also.

· Presentation style

Read all the questions. Each question should be read carefully and understood well. First, attempt should be made to answer those questions that can be easily answered. Prepare for answering by collecting the points in your mind. Highlight those points in the answer sheet by underlining the points or by adding bullets. Make sure that answers are written to the point. Pictorial representations are many fold effective compared to expressing using words. Add examples wherever possible.

· Hand writing and neatness

It is very important to write neatly and legibly. The answers that you write are the only means of communication between you and the evaluator. It is your responsibility to make the evaluator's job easy. Try to develop good handwriting. If you don't have a good handwriting, put in conscious effort to write legibly. Finally, don't forget about the 'value system'. Don't indulge in any activity that breaks a good value system. None of your activities should depend on whether you are being observed or not.

Hope these points will help you in yours studies and exams.

Wish you all the best!

Contents

Introducing journals: *American Journal of Physics*

The Journal was established in 1933 under the title *The American Physics Teacher*.The name was changed to the *American Journal of Physics* in 1940.AJP publishes papers that meet the needs and intellectual interests of college and university physics teachers and students. Articles provide a deep understanding of physics topics taught at the undergraduate and graduate level, insight into current research in physics and related areas, suggestions for instructional laboratory equipment and demonstrations, insight into and proven suggestions for better teaching methodologies, insight into how college students learn physics, information on historical, philosophical and cultural aspects of physics, annotated lists of resources for different areas of physics, and book reviews.

Standard Features

AJPO is a full-featured electronic journal (in addition to print) and provides access to the following:

· Back issues featuring HTML Tables of Contents, Abstracts, and the full text of every article (in PDF and PostScript formats) back to January 1933.

· Also beginning with the July 1999 (Vol. 67, No. 1) issue, the full text of every article is available in PDF, PostScript, HTML, and sectioned HTML (the HTML articles come complete with inline equations, tables, and figures, as well as linked references).

. Three fully searchable databases: one covering the journal from 1933-present, one to search only the latest issue of the journal, and another to search across all issues with full text available online in PDF and PostScript formats.

An IIT Exam!

Those four students had not prepared for the exam.Early morning they knocked at the door of the professor, looking quite funny.

All their dress was muddy. They described all those troubles they had the previous night while going for attending a marriage. The car tyre had burst. They had to push the car a lot with nobody to help.

They succeeded in getting the exam postponed to the next week.

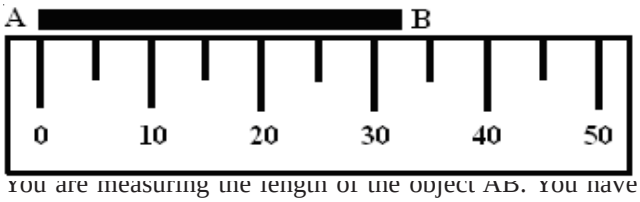
Next week, they reported to the professor after having prepared excellently. The exam was quite simple though they had to sit in four separate rooms to write it. There were only two questions: (i)What is your name? (2 marks); (ii) Which tyre burst? (48 marks)

Observations/Comments

[A column by PRM]

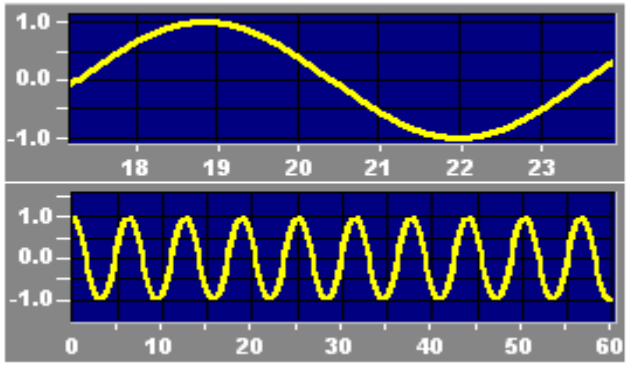
I would like to bring to your notice, again, some practices(wrong!) related to the laboratory sessions. This time, it is about using measuring equipments, like the oscilloscope.

When you use a graduated scale to measure the length of an object, you are not expected to read between two closest graduations. For example, see a simple measurement shown in the figure.



You are measuring the length of the object AB. You have kept end A exactly in line with the graduation 0. Assume also that the length is kept parallel to the edge of the scale. You may have a tendency to read the length as 32 or 32.5. It is wrong. You are expected to read it either as 30 or as35. You may mention the error like 30^{+5}or 35^{-5}. This is applicable not only to length measurement, but to all analogue displays; you must not read between the lowest two divisions.

What about measurement of period, and thence frequency, using CRO. I have observed that you simply measure the period of one cycle. This has an issue: the trace of the wave form cuts the time axis at a low angle with the result that the zero crossing time cannot be seen precisely. On the contrary, if you can keep large number of cycles displayed on the screen, zero crossings can be made sharper. See the illustration given below.



Check for the best identifiable zero crossings towards the left end and the right end; measure the total time and count the number of cycles; total time divided by the number of cycles gives the period. Whatever small error is there in identifying zero crossing gets divided by the number of cycles used; larger the number of cycles better the accuracy. Note that the error contributed by the resolution of the scale remains the same whether you take one cycle or 10 cycles!

[Next issue: On Debugging of Circuits].

Advanced video coding

Most of the computers and laptops nowadays have commercial media players which can be used to play multimedia content encoded using various compression techniques. Recent players provide support for playing H.264 encoded video. Apple QuickTime is an example of such a player.

This article is an attempt to introduce to you the H.264 standard. H.264 is also known as advanced video coding standard. This video coding standard was developed jointly by MPEG group and ITU-T.

We have already seen that digital compression is achieved by transformation, prediction, quantization and entropy coding. *[See Apptronics review Vol.1, Issue 2]*. Similarity or redundancy within a frame and similarity between frames is the key to video compression. This redundancy allows prediction of a macro block either from the current frame itself (intra mode) or from previous frames (inter mode). First frame is coded in 'intra' mode. For all the remaining frames, inter mode is typically preferred. In natural video, a given area or block in a current picture will most likely be displaced by a few pixels compared to previous frames. Displacement vectors can be used to represent such blocks. These displacement vectors are called motion vectors. Prediction of the block using motion vector is called motion compensation. H.264 includes a few techniques by which motion prediction is improved compared to MPEG4. These are the use of (i) fractional sample accurate motion vectors, (ii) motion vectors over frame boundaries, (iii) bi prediction motion vectors, (iv) variable sized blocks and (v) multiple reference frames.

Intra prediction in H.264 could use block size of 16x16 pixels or 4x4 pixels. There are 9 different intra prediction modes possible when the chosen block size is 4x4 pixels. 16x16 block size permits 4 intra prediction modes. Motion prediction could use block size of 16x16, 16x8, 8x16 or 8x8 pixels. Incase 8x8 is selected, an extra syntax element in the code stream specifies if the block is further divided into 8x4, 4x8 or 4x4 block. MPEG4 supported block size of 16x16 and 8x8 only. Accuracy of motion vector is upto quarter pixel in H.264 stream. MPEG4 restricted the accuracy to half pixel.

Residual of intra or inter prediction is transferred by a frequency transform. Transform coefficients are then scaled, quantized and entropy coded. Integer transform, with numbers ranging from -2 to +2, is used instead of DCT. Size of the transform is 4x4. Integer transform allows computing the forward and inverse transform using shift and add operation. CAVLC (context adaptive variable length code) and CABAC (context adaptive binary arithmetic code) are the entropy coding methods used in H.264.

Block transforms usually result in blocking artifacts. Filtering block edges can make the picture smooth and perceptive

quality is improved. Deblocking filters are used for this purpose. Filter is adaptive, and characteristics of the picture decide the strength of the filter. IDR (instantaneous decoder refresh) frames are used for error robustness in H.264. These frames allow random tuning in of the decoder. Another feature that enhances error resilience is flexible macro block ordering (FMO). This feature allows macro blocks to be transmitted out of raster scan order. If packets are lost during transmission, FMO helps in reconstruction of the lost macroblocks.

H.264 encoded stream has a sequence of network abstraction layer units (NALU). A NALU is a packet which contains integer number of bytes. First byte of a NALU is a header byte containing information about type of NALU. There are two types of NAL units: video coding layer (VCL) NALU and non VCL NALU. The former ones contain data that represent pixels in video, and the latter ones have information required for the decoding of VCL NAL content. Non VCL NAL could contain sequence parameter set (SPS) or picture parameter set (PPS). SPS contains information applicable to a series of coded frames. PPS applies to a particular frame. SPS and PPS are sent ahead of VCL NAL units. They may also be repeated often for extra robustness and error resilience. These NALs have to be sent through a good channel since an error in any of these could be critical.

H.264 caters to a range of applications, bitrates, resolutions and quality. Inter-operability is an issue if complexity has to be minimized and restricted feature set is to be provided. For large deployment of the standard, various levels and profiles are specified in the standard itself. Profile is a subset of coding tools or syntax elements. Level is a set of constraints on the values of syntax elements in the bitstream. Constraints on size and resolutions can be introduced through levels.There are 3 profiles and 15 levels in each profile. The three profiles are baseline profile (BP), main profile (MP) and extended profile (EP). BP is the least complex and is used typically in video telephony. BP does not support bidirectional predicted slices, CABAC, frames with fields, and data partitioning. It includes many error resilience tools like FMO and ASO. MP is used in entertainment related applications.

Compared to previous coding standards, this standard provides improved coding efficiency at a cost of increased complexity. Complexity is directly proportional to number of computations. H.264 decoder is at least 3 times more complex compared to MPEG4 decoder. H.264 encoder is about 8 to 10 times more complex compared to MPEG4 encoder. Even with this level of complexity, H.264 is gaining popularity, largely due to the speed enhancement provided by improvement in VLSI design and optimization techniques.

- Meena V

Tiny motors working on sunlight

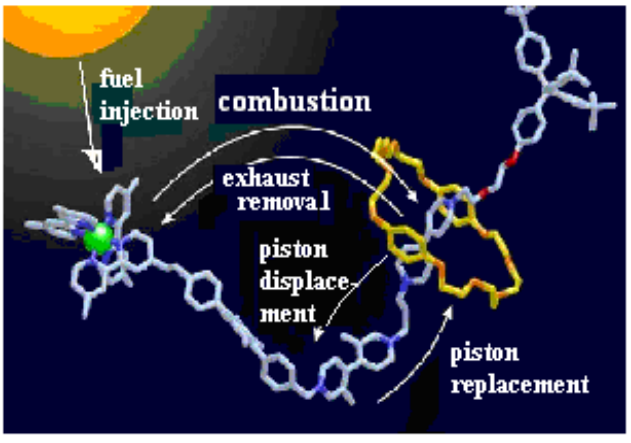
How small can a four stroke engine be? Think for a while and try to make a guess.

Your guess could easily go wrong. Science and technology have grown to such scales. Scientists have developed nano engines of such a small size that just 2million of them placed in contact can be there in just about 10mm span. The length of each tiny motor is only 5 nm. It has a ringed structure at one end that moves back-and-forth like the pistons in the motor car engine.

These tiny ones make use of sunlight. These engines are mechanically-interlocked molecular architecture. The sunlight photons excite one end of the molecule. Then a four step process is set up. Electrons are transferred along the molecule until they reach the ring structure [see figure], causing it to slide 1.3 nanometers forward on the molecule. As the electron continues its path, it reaches a section that forces it back to the starting point. This causes the molecule to “reset,” and the ring returns, piston-like, to its original position. One cycle takes about 100 microseconds. The rotaxane engine is autonomous, in the sense that it continues to operate as long as energy is available.

Each step is similar to the mechanical functions of the four-stroke engine that powers a car: fuel injection and combustion, piston displacement, exhaust removal and piston replacement. Of course there is a major difference: the exhaust here is electron, not smog-producing pollutants.

This nano engine can function with others, or function all by itself. It can be driven at relatively high frequencies. In mild environmental conditions it is quite durable, staying stable for at least 1000 cycles. It has an efficiency of only 2 to 12 percent. But it doesn’t need refueling; sunlight is free.



The solar-powered four-stroke nanometer. Energy from the sun drives the movement of the yellow ring structure like a piston

- Prasnth P menon

Tornado in Texas

Determinism- is the beauty of science and technology. Determinism is incorporated to modern science with the establishment of the idea that "cause- effect rule" governs all the physical system in the universe. According to the deterministic model science, the universe behaves like the working of a perfect machine without any deviation from the predetermined laws. The person who is closely associated with the establishment of determinism to science is Isaac Newton. Through his laws of motion, he could accurately predict the orbits of planet around sun, the shape of trajectories of projectiles on earth, etc. Newton's laws are completely deterministic. Those three laws were successful for several centuries after its discovery.

But there is a more beautiful science- Chaos

Edward Lorenz- a meteorologist was the true experimenter in chaos. He published a paper *Deterministic Non periodic Flow*, in 1963, in Journal of Atmospheric Science, which formed the foundation of chaos theory. In 1972 he gave a talk to 'American Association for the Advancement of Science' in Washington DC . The session was convened by one Philip Merilees, who gave the title to the talk as 'Does the flap of a butterfly's wings in Brazil set off a tornado in Texas'. The flapping wing represents a small change in initial condition of the system, which causes a chain of events leading to a large scale phenomenon. If a butterfly had not flapped its wings, the trajectory of the system might have been vastly different.

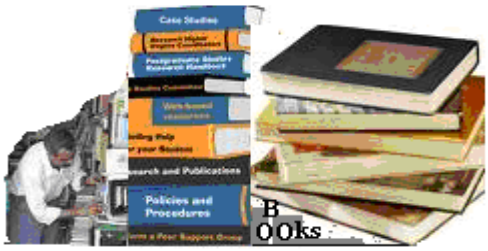
Chaos is a science which describes the sensitive dependence of every event (or system) to initial conditions. The values of measurements at a given starting time are called initial conditions. Just a small change in the initial condition may drastically change the long term behavior of the system. For example, with a starting number of 2, the final result can be entirely different from the same system with a starting value of 2.00000001. This sensitive dependence of every system to the initial conditions is known as 'butterfly effect'.

Uncertainty of Measurement

No real measurement is infinitely precise. One way to understand this fact is to realize that in order to record a measurement with infinite precision, the instrument would require an output device capable of displaying an infinite number of digits. In dynamics, the presence of uncertainty in any real measurement means that in studying any system, the initial conditions cannot be specified to 100% accuracy. In study of motion using Newton's laws, uncertainty in the initial conditions yields a corresponding uncertainty, however small, in prediction for any later or earlier time.

- Sreejith K R

A Log Book for Reading



It is a good practice to keep a log book for reading.

At start, write down name of author, title of book, name of publisher, year of publication.

Then note down the date on which you started reading it.

Read the preface and introduction. Based on it note down what you expect from the book.

Read the opening chapter. Note your comments. Repeat this after every chapter.

After completing the whole book, see if you can write down answers to the following:

What emotions did the book invoke: laughter, tears, smiles, anger? Or, was the book just boring and meaningless? Which character did you like most? What is the reason for it? If it is a technical book, or a book on science, what about its presentation style? Did the book really impress you? What did you learn from the book? Were you confused at any stage of reading? Was there an idea in the book that made you stop and think, or prompted questions? How far could it satisfy the impressions you had based on the preface and introduction? Would you like to recommend reading this book to others? If so, for whom? Would you like to read some more books from the same author? Are you able to write a summary of the book? If so write it down, including your reflections.

- Jasna K Azeez

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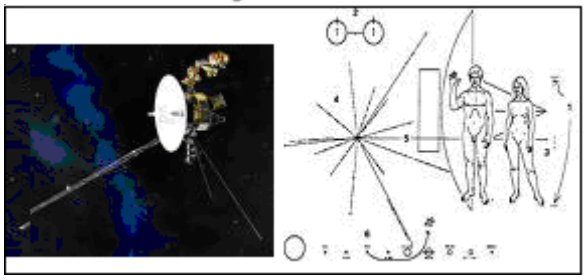

Connection between the two images in the box?

First correct answer will win a prize.

Answer to the question in the previous issue

King of Spades represents King David in the Bible.

Now you try to find who are the other kings: Kings of Clubs, Dice & Hearts.