

**BIONICS**  
**(Using nature to understand systems)**

**Course Out-line of a 12 session 0.5 credit elective**

**A note to the Course committee:**

As the subject being offered (and the objective perceived by me) are not entirely 'conventional', I feel that I must provide you with my own perception regarding (especially) the open-ended-ness of this course and its implications on teaching methods.

Bionics is not entirely a main-stream branch of science or technology and yet has been fairly visible due to its "pop-science" kind of references. It has been changing over the ages with changing world-view of science. In Newtonian era, it had application related to "making" of tools/objects. With nature of complex system becoming more explicable, this branch of study of Nature has grown in every direction but it lacks a clear structure.

This makes 'teaching' of bionics (more so as a small course) difficult, as giving it a fixed structure with limited/defined volume of information defeats the entire purpose of nurturing attitude for innovative thinking.

Considering this, I do not find it meaningful to generate a very specific Bibliography or a very comprehensively listed course material. I would rather respond dynamically to interest areas of students as they emerge during class interactions.

My previous experience with young design students has taught me that a lot of explorative and novel thinking emerges during the course of such discussions that can be collective pursued.

So, following is a basic frame around which I hope to create a newer form every time I conduct the elective!

Samir Shukla

## **Format for a Course Outline (As per IIM-A system)**

### **i. Course title**

BIONICS

### **ii. Area to which the course belongs**

BIONICS is a recognized branch of knowledge belonging broadly to science

#### **ii. a. A short description on the field of Bionics and its application**

Bionics has been traditionally defined as an applied branch of engineering emerging from Biology + Mechanics, i.e. Mechanical ideas/designs inspired from Biological structures or nature.

Classical example of such an application is “Velcro”, the Hook and Loop fastener system is a near copy of burrs (plant seeds that cling to animals). This is primary level of Bionic idea.

Bionics still retains (and has actually acquired greater potential due to recent advances in energy-efficient power systems and controlling devices) enough charm at this level.

e.g. If student acquires curiosity and looks closer at an information trivia like “Griffon vulture’s are found flying at 40000 feet, he will suddenly encounter presence of a extremely high-end technology embedded in a vulture that can have huge economic potential.

BUT, the subject of my interest is the cotemporary interpretation of Bionics where Natural Structures and Systems are comprehended to generate processes and application for use in real world;

e.g. evolutionary mechanisms vis-à-vis survival of a product/success of a decision.

Or mating strategies vis-à-vis marketing strategies

Or (at very operative level taking over of a lion pride vis-à-vis hostile take-over in corporate world

Or (If you desire more “esoteric” relationships)

Egg’s response to arrival of first sperm vis-à-vis arrival of a MNC in third world country market

Behavior of a viral cells vis-à-vis behavior of terrorists’ cell

Body-response to rash vis-à-vis mob behavior vis-à-vis emerging internet psyche

The list is endless and endlessly curious..

So applications of Bionics are endless. There is no better model than Nature that can be used to understand behavior of complex systems. My own orientation is towards using it as a philosophical tool for having an alternate method for understanding behavior of Reality. Be it market conditions or emerging fashion trends, Bionics can help one look at it from a new perspective.

**iii. Term in which the course is to be offered**

0.50 unit (12 classes)

**iv. Instructor's name**

Samir Shukla

**v. Course objective**

The primary objective of this course is to make a person aware of an alternate methodology of understanding real world processes. Considering the wide and open-ended spectrum of knowledge Bionics encompasses,

I seek to encourage individuals to innovatively identify novel and applicable concepts by looking at natural processes.

**vi. Type, plan and session-wise content of the course**

Lectures inspiring Group Discussions and assignments will be the basic method of conducting the course

Session wise content is provided bellow

**vii. Pedagogy**

**The course is primarily divided into four phase:**

- A. Introduction to natural world at “product” level, to create a curiosity base
- B. Inviting creative exploration to revisit the wonderful world of science
- C. Looking at Nature as a rich source of “systems”
- D. Looking for a comparable non-natural system to see if knowledge can be synthesized by studying interrelationship between parts

(In between, at a suitable point, a much needed discussion is inserted to discuss nature as a source of “morality” to demystify bionics to prevent formation of an image of nature (often mistaken with “god”) as the sole or greatest source of wisdom.)

**viii. Number of sessions required, hours needed per student for class sessions, major papers/projects, etc.**

**OUTLINE FOR A TWELVE SESSION COURSE  
(Session length: 65 minutes)**

**Session 1: INTRODUCTION TO PRIMARY LEVEL CONCEPTS OF BIONICS**

Lecture on traditional bionics, with a “preface” aimed at destruction of various popular myths about nature. A small discussion on impact of “emotional myths” linked with nature that clouds a purer understanding regarding workings of nature.

The subject is soft-launched through an assignment requiring students to study existing successful bionics products.

Assignment 1: Identification of one example each by students and creation of small presentation

**Session 2: UNDERSTANDING THE CONCEPT OF TRANSFER OF IDEA FOR ONE DOMAIN TO OTHER AND ITS ADVANTAGES/LIMITATIONS**

Students present their assignments in class leading to discussion on the examples identified by students to understand the “transfer of idea from nature to product”.

**Session 3: PRESENTATIONS + DISCUSSION**

Continuation of discussion from session 2

+

The discussion culminates at distribution of random examples from “Extreme Nature”, a book full of trivia about nature (the longest, shortest, most poisonous, most stinky etc. kind of extreme examples from animal and plant world) that are handed out to students to come out with a presentation of their own idea about a nature inspired product (e.g. Border fences made from forget-me-not hedge).

**Session 4: PRESENTATIONS + DISCUSSION**

Presentation of Student work with discussion hinting at required advancements in existing technology to convert the proposed solutions into reality.

The session ends with discussion regarding “appropriateness” in using nature as a source for looking at solutions.

#### Session 5: TAKING GOD OUT OF BIONICS

I have observed that due to the theological nature of subject matter, believing young minds tend to get carried away into start looking at Nature (product of God?) as a perfect solution provider.

A group discussion is held to question the seeming “perfectness” of natural world to dispel the notion. The session ends with handing out of a small story based on wasp-spider study of Fabre to start a discussion leading towards functioning of nature.

Web-link:

<http://samir-solongandthankyouforthefish.blogspot.in/search?updated-min=2008-01-01T00:00:00-08:00&updated-max=2009-01-01T00:00:00-08:00&max-results=1>

#### Session 6: COMMENCING JOURNEY FROM PHILOSOPHY TO NATURAL SYSTEMS

A group discussion is held in class based on reading of the story that hints at difference between human morality and laws of nature i.e. difference between a “moral” god and “natural” god.

After looking at the philosophical aspect of the idea, it is introduced as a “natural system” for governing i.e. a natural “product” and some musing is done on its possible usefulness in future (e.g. in governing robot societies)

The idea of nature as a source of functioning systems that can be studied to understand prognosis of any type of system is introduced.

#### Session7-8: DISCUSSING EXAMPLES OF NATURAL SYSTEMS

Talk is given on the class’s preferred area of interest:

Ranging from

Herd behavior to host-parasite relationship

Evolution to mechanism of vector-borne pathogens

Emergence of “consciousness” in brain to Time perception in various types of ant societies

These two sessions are used to introduce the immense richness of natural world to students by following their lead and developing them into meaningful relationships with other non-natural systems.

The second session ends with discussion on the final assignment expected from each student as prime deliverable for the elective.

Each student is expected to choose a “complex” (multi-element-ed) natural system and a non-natural system to look for possible similarities that can be used for extrapolating some meaningful insights about the behavior of non-natural system.

#### Session 9: SUBJECT IDENTIFICATION

Each student presents out-line of his/her subject for verification of its depth/meaningfulness as a subject to be studied further.

Session is utilized to approve the subject chosen for study by each student.

#### Session 10-11: FINAL PRESENTATIONS

Each student presents in the class.

#### Session 12: CONCLUDING LECTURE

Subject is summed up by the faculty

#### **ix. Evaluation criteria (including pass/fail)**

Student will be evaluated in scale of 100 across the course on bases of assignments and participation in group discussions as follows:

Assignment 1: Existing Bionics products	Grades: 5
Assignment 2: Creative product ideas	Grades: 10
Assignment 5: Final presentation	Grades: 40
Performance if Group Discussions:	Grades: 45
Total	Grades: 100

Passing: 50 minimum

#### **x. Prerequisites and eligibility if any and their justification**

A qualification in science is considered mandatory (BE, B.Tech, Doctors etc.) but interested student without qualification is allowed to approach the faculty for enrollment in the elective. Considering involvement of scientific ideas and concepts, this is required.

#### **xi. Restriction on class size (both minimum and maximum), if any, and their justification**

Not less than 15 and not more than 40.

As elective will require personal interactions to develop ideas.

#### **xii. Relationship of the course with the overall programme objective and related courses**

The course is oriented to be a “mind-opening course” and thus it will have relevance in a very fundamental way with over-all nurturing of a person..be it as a decision maker, problem solver or just appreciating to wonderful complexity of Nature.

### **xiii. Bibliography**

Subject has a wide base and thus relevant material will depend on the direction a student takes. There are a huge number of books related to various aspects of Bionics that I would like to make a general list of, as follows:

On Growth and Form: D'Arcy Thompson  
The Curves of Life: Theodore A. Cook  
The Elements of Dynamic Symmetry: Jay Hambidge  
The geometry of Art & Life: Matila Ghyka  
The Selfish Gene: Richard Dawkins  
The Blind Watchmaker: Richard Dawkins  
Climbing Mount Improbable: Richard Dawkins  
Unweaving the Rainbow: Richard Dawkins  
The Structure of Evolutionary Theory: Stephen Jay Gould  
Leonardo's Mountain of Clams and the Diet of Worms: Stephen Jay Gould  
Metamagical Themas: Douglas Richard Hofstadter  
Gödel, Escher, Bach: an Eternal Golden Braid: Douglas Richard Hofstadter  
Alas Poor Darwin: Hilary Rose & Steven Rose  
Nature's Numbers: Ian Stewart  
The amazingly symmetrical world: L. Tarasov  
In Search of Schrödinger's Cat: Quantum Physics and Reality: John Gribbin  
QED: The Strange Theory of Light and Matter by Richard P. Feynman  
This Chancy, Chancy, Chancy World: I Rastrigin  
One Two Three . . . Infinity: Facts and Speculations of Science: George Gamow  
Darwin's Black Box: The Biochemical Challenge to Evolution: Michael J. Behe  
And many more.....

### **xiv. Computer Centre facilities and other special infrastructure needed**

Internet use and computer aided presentation facilities are desired.

### **xv. The course outline should have a clause about the additional expenses to be incurred by the students and also the sources of funding.**

No additional expense involved (apart from access to Internet and Computer aided presentation tools.)

### **Samir Shukla**

406 Kaivanna

Panchvati

Ahmedabad: 380 06

Ph: 079-26569476/26401399

M; 98250 64392

Mail: insanepersonin@yahoo.co.in