ON INDIA GOVERNMENT SERVICE

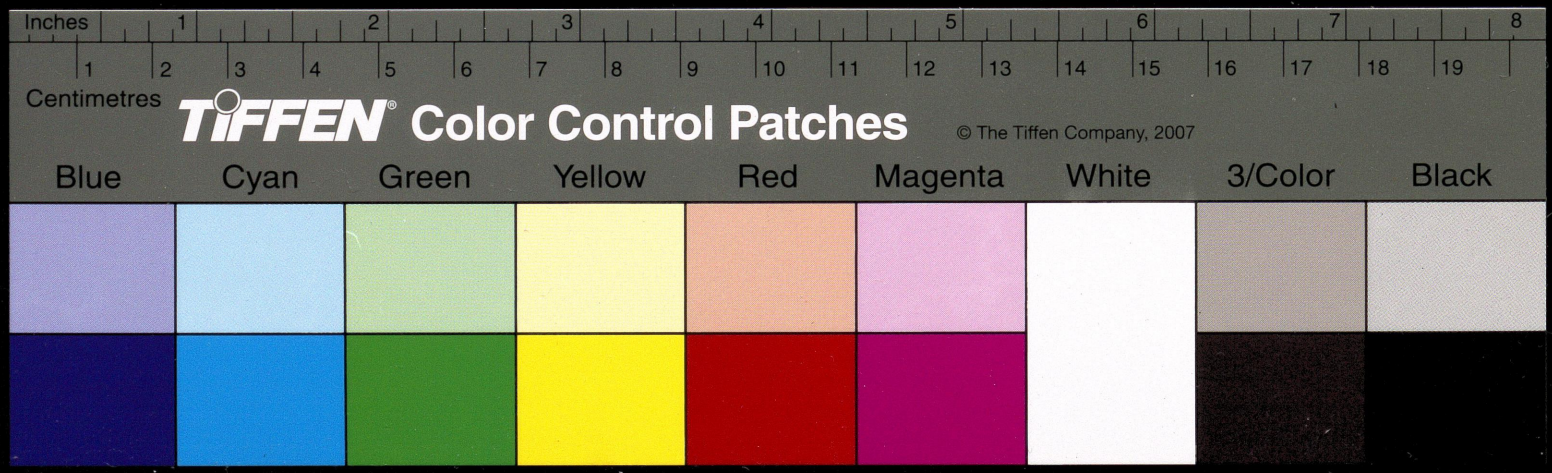
BSM
17/4/74

Dr.B.S.MADHAVA RAO, D.Sc.,
F.N.A.F.A.Sc.
No 4 KANKANHALLI ROAD
BASAVANGUDI P.O.
BANGALORE 560004

DO No 4119/KCS/AM

MINISTRY OF DEFENCE (R & D)
INSTITUTE OF ARMAMENT TECHNOLOGY
GIRINAGAR, SIMHAGAD ROAD
PUNE-25

SSO I 12/4/74.
Faculty of Mathematics
INSTITUTE OF ARMAME..T TECHNOLOGY, PUNE-25



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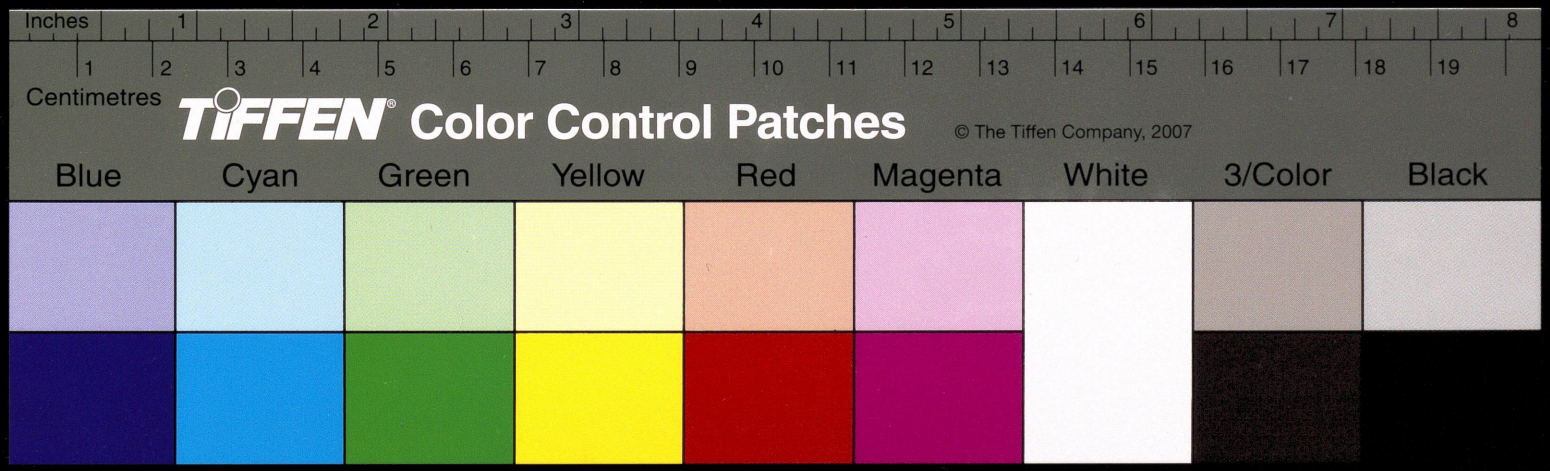
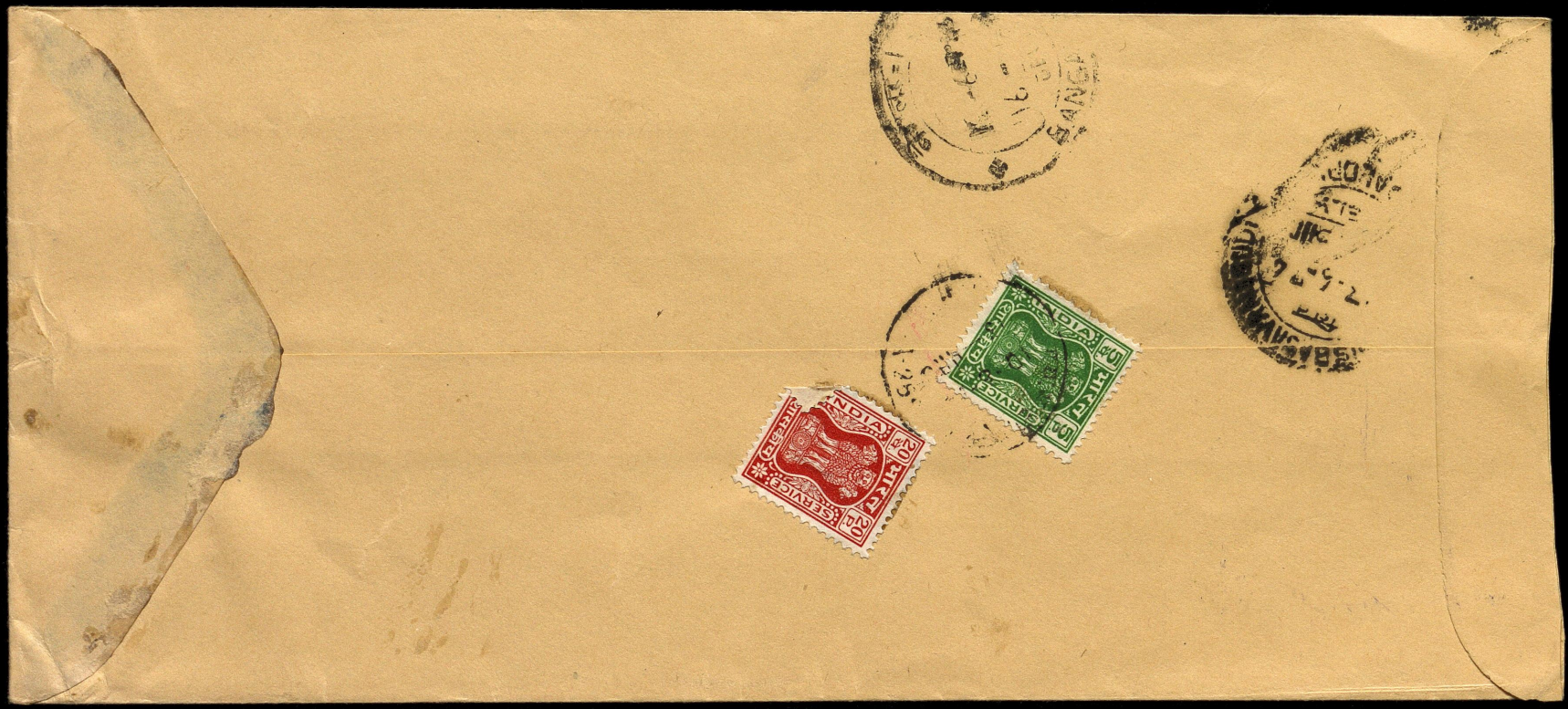
भारत सरकार सेवार्थ
ON INDIA GOVERNMENT SERVICE

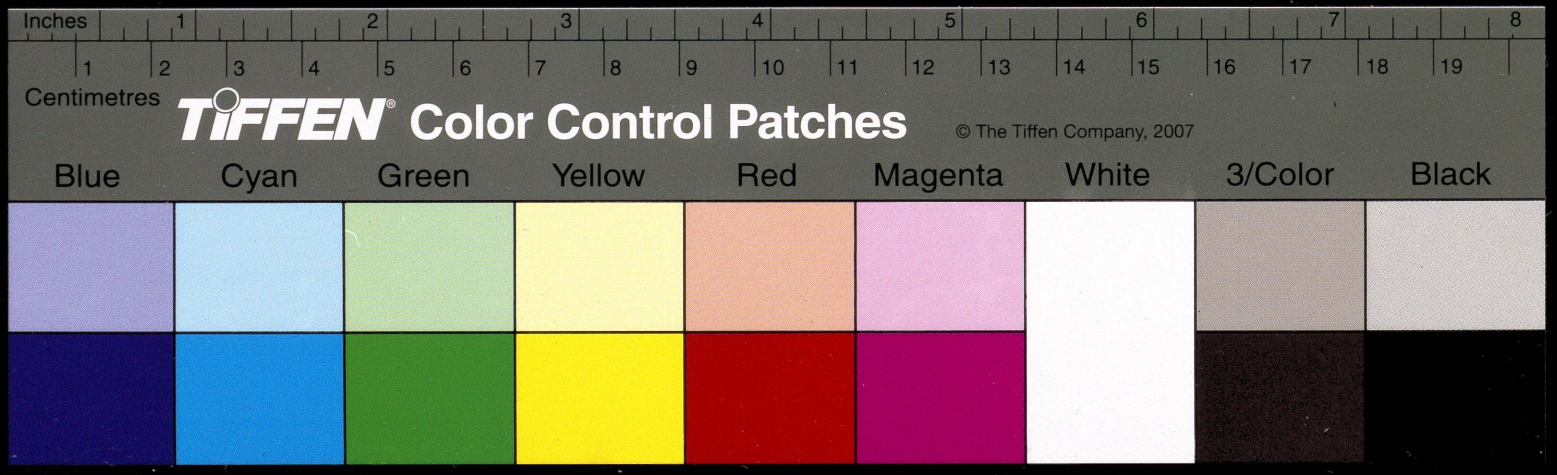
Institute of Armament Technology
Girinagar, Poona-25
16174

To Dr. B. S. MADHAV RAO
No. 4 Kankahalli Road.
P.O. Basavangudi
BANGLORE - 4

BSM
13/6/74



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Dr.KC SHARMA, SSO-1
Faculty of App Maths.

Telephone : 55394, 553
Telegrams : ARMINS

GOVERNMENT OF INDIA
MINISTRY OF DEFENCE (R & D)
INSTITUTE OF ARMAMENT TECHNOLOGY
POONA-25

DO No 4119/AM

Dated 13 APR 74

Respected Sir,

I refer to your communication dated 9 Apr 74 addressed to Prof.PC RATH.

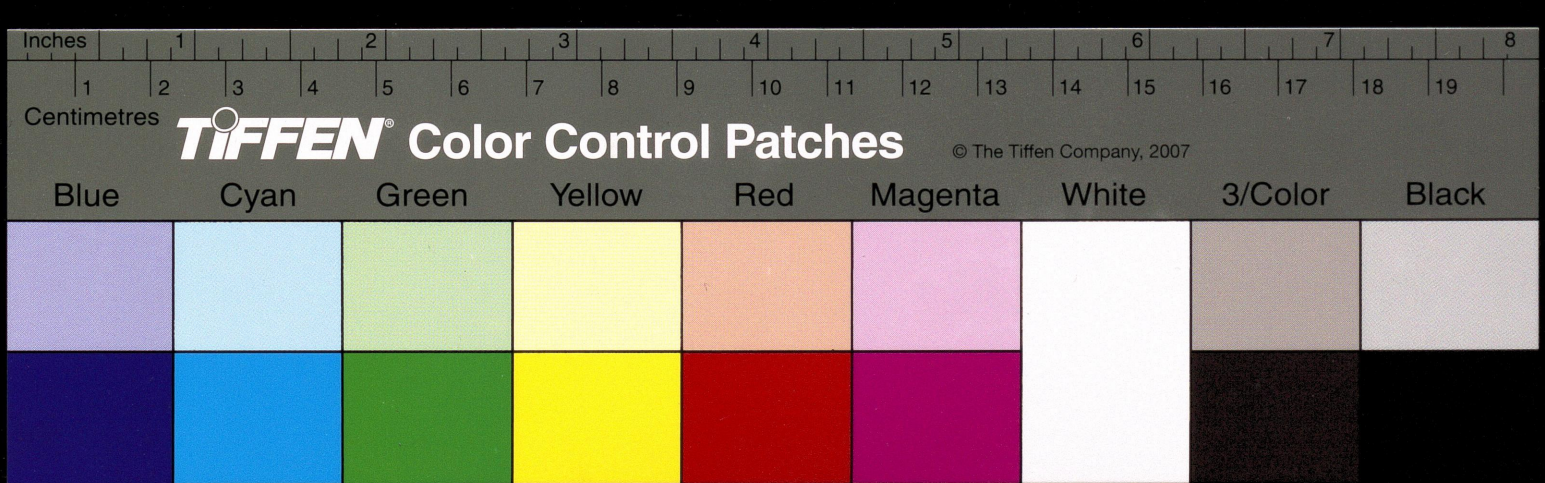
The Institute can pay to you the first class journey fare and the normal daily allowance rates admissible to you.

We are looking forward for your acceptance of the offer and dates regarding the journey.

With regards.

Yours most sincerely

Dr B.S.MADHAVA RAO
D.Sc.,F.N.A.F.A.Sc.
No 4 Kankanhalli Rd,
BANGALORE 560004



Telephone : 55394/6
Telegrams : ARMINST(E)

GOVERNMENT OF INDIA
MINISTRY OF DEFENCE
DEFENCE RESEARCH & DEVELOPMENT ORGANISATION
INSTITUTE OF ARMAMENT TECHNOLOGY
GIRINAGAR, POONA-25.

No 4119/AM

Dated 18 MAY 74

To

Prof. B.S.Madhawa Rao
No 4 Kankanhalli Road
Basavangudi P.O.
BANGALORE-1

NONLINEAR BALLISTIC SEMINAR, JUNE 1974

Dear Sir,

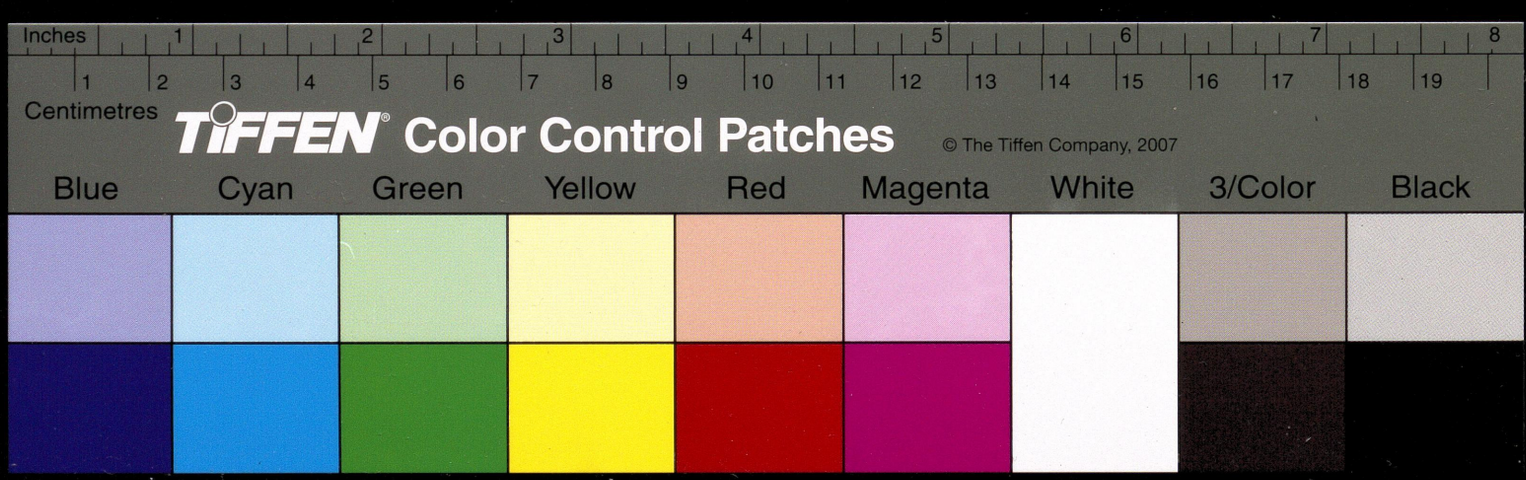
We request you to preside over Technical Session (Stability and vibration of missiles) on 22 June, at 1215 hrs. Kindly confirm and acknowledge.

Yours faithfully,

(Dr.KC SHARMA)
Joint Secretary
Nonlinear Ballistic Seminar

BSM 22/5/74

Replied today accepting
BSM 25/5/74



27/4/74

Dear Dr Sharma,

Ref. your. DO. No. 4119/AM dated 13/4/74.

Many thanks for your letter offering me T.A & D.A. for attending the seminar. I have contacted my old student & colleague Dr. V.R. Thiruvenkatachar, and we have both decided to come over to Poona and take part in the seminar. He will write to you about the dates of the journey.

Re. Ever since I retired from the Institute in 1960, I have not kept in touch with recent developments in Ballistics, except for looking through the NASA reports of the U.S.A. relating to the topic. I am therefore coming there more to learn than to make any worthwhile contribution As suggested by Prof. Ralf. in his letter of invitation, I am agreeable to conduct one of the technical sessions as chairman.

With Kind regards,

Yours sincerely

Dr. KC SHARMA
Senior Scientific Officer I
Head Dept. of Ballistics

Telephone - 440050/253
Telegrams - ARMINST(E)
GOVERNMENT OF INDIA
MINISTRY OF DEFENCE
DEFENCE RES AND DEV ORGN
INSTITUTE OF ARMAMENT TECHNOLOGY
GIRINAGAR, PUNE-411 025.

No. 1532/G

Dated - 1 May Apr 78

Sub - POST GRADUATE DIPLOMA COURSE IN BALLISTICS

Sir,

This Institute intends to introduce a One year course in Ballistics. The contents of the course are planned to cover applied and theoretical aspects in depth.

2. The Institute has a fully equipped ballistic Instrumentation Laboratory, Library and the qualified staff to undertake this commitment. Where necessary, the Institute will seek the co-operation of other laboratories/establishments to assist or advice in teaching/practical work/dissertation topics.

3. Dissertations would be assigned on new topics of practical and theoretical interests.

4. To obtain recognition for the course, it is proposed to approach the University of Poona for award of MPhil (Ballistics) or a post graduate diploma qualification.

5. I request you to kindly forward your opinion on its scope of utility, contents of syllabus and the additions/deletions that you would like to suggest to improve the syllabus and other aspects of the course.

With regards.

Yours Sincerely

Encl - A copy of "A Case for Introducing a Post Graduate Diploma Course in Ballistics".

Replied today approving also with additional suggestions BSM 19/5/78

To
Dr B.S. Madhav Rao DSc. FNA. FASc
4/59 Kanakpura Road
Basvangudi P.O.
Bangalore 560 004

15. The Institute may approach the University of Poona for recognising the course for a post graduate diploma equivalent to M.Phil. degree. The examination may be conducted by IAT and or Poona University. The research students joining the course, may be awarded M.Phil.

Section II

A. INSTRUCTIONAL COMMITMENTS

1. Teaching subjects with practicals will have 5 periods of one hour duration each, per week.
2. For the preparation of seminar subjects, tutorials and literature survey the library contact periods will be about 5 per week.
3. Dissertation will be equivalent to three teaching subjects.
4. Outside visit will be of two weeks duration.
5. There will be two days visits to local establishments.
6. Private study will be 2 periods per week.

SUMMARY

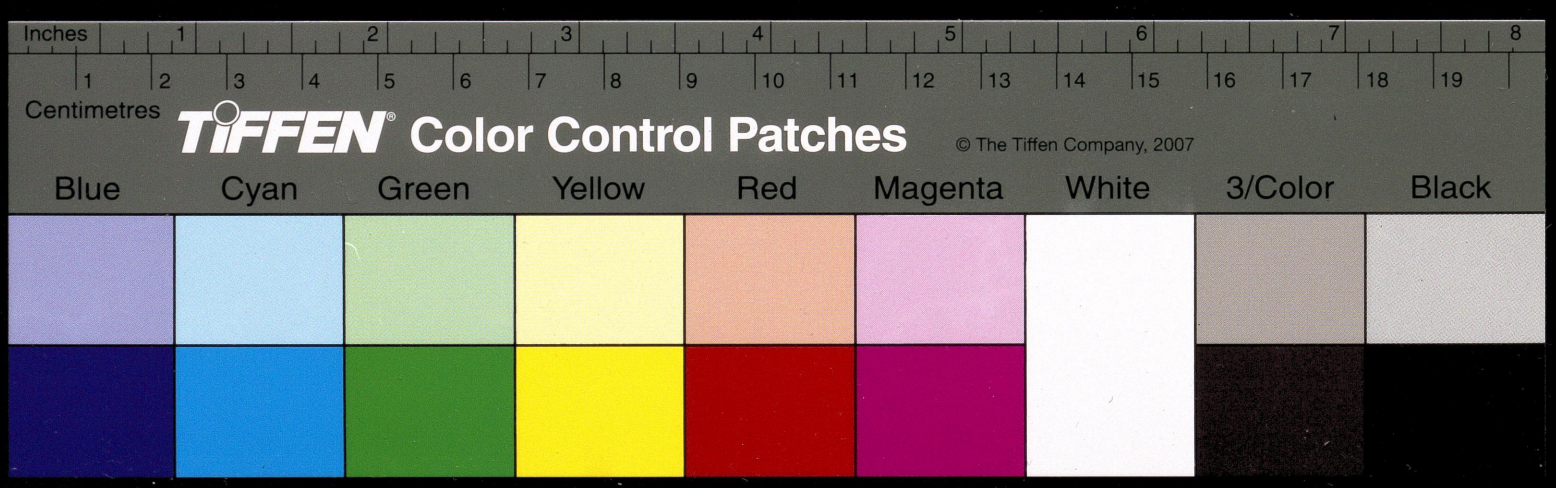
I Term
(20 weeks)

Details

Three Pre-requisite subjects (first three weeks)

1. Thermochemistry of propellants.
2. Stability theory
3. Nonlinear mechanics
4. Electronics for instrumentation.
5. Statistics and probaility theory.
6. Numerical analysis.
7. Hydrodynamic principles.
8. Computer programming.
9. Calculus of variations.

Any three of the above subjects will be allotted to a candidate by the officer in charge of the course. The choice will rest on the criterion "Make up the deficiency"



of the background knowledge necessary for the course.

There will be no assessment examination in these subjects.

Teaching subjects (four subjects)

1. Internal ballistics
2. Free flight dynamics I
3. Experimental techniques and instrumentation.
4. Detonics and terminal effects.

This term will be followed by a break of 4 weeks.

II Term

(20 weeks)

Teaching subjects

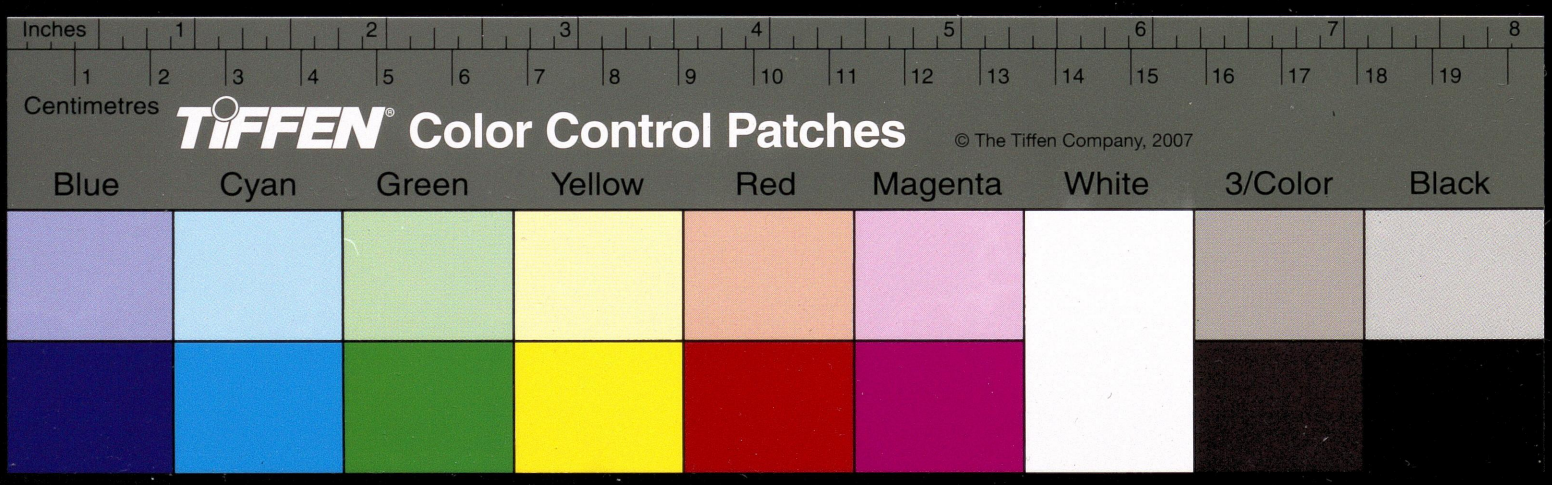
Free flight dynamics II

* Dissertation

Seminars (two by each student)

Visits

* Each guiding teacher will have a maxium of three students.



Section III

COURSE OF STUDIES AND DETAILED SYLLABUS

1. Pre-requisite subjects.

(a) Thermochemistry of propellants

Free energy and equilibruim condition, combustion processes, burning of propellants, theoretical performance evaluation of propellant systems, solid, liquid and hybrid propellants,

(b) Stability theory

Response characteristic of linear systems, Nyquist criterion, Routh-Hurtwiz criteria (including in complex plane) stability of systems having periodically varying parameters, second method of Liapunov.

(c) Nonlinear mechanics.

Phase plane analysis, limit cycles, pendulum equation, Vanderpool and Lenard equations.

(d) Electronics for instrumentation.

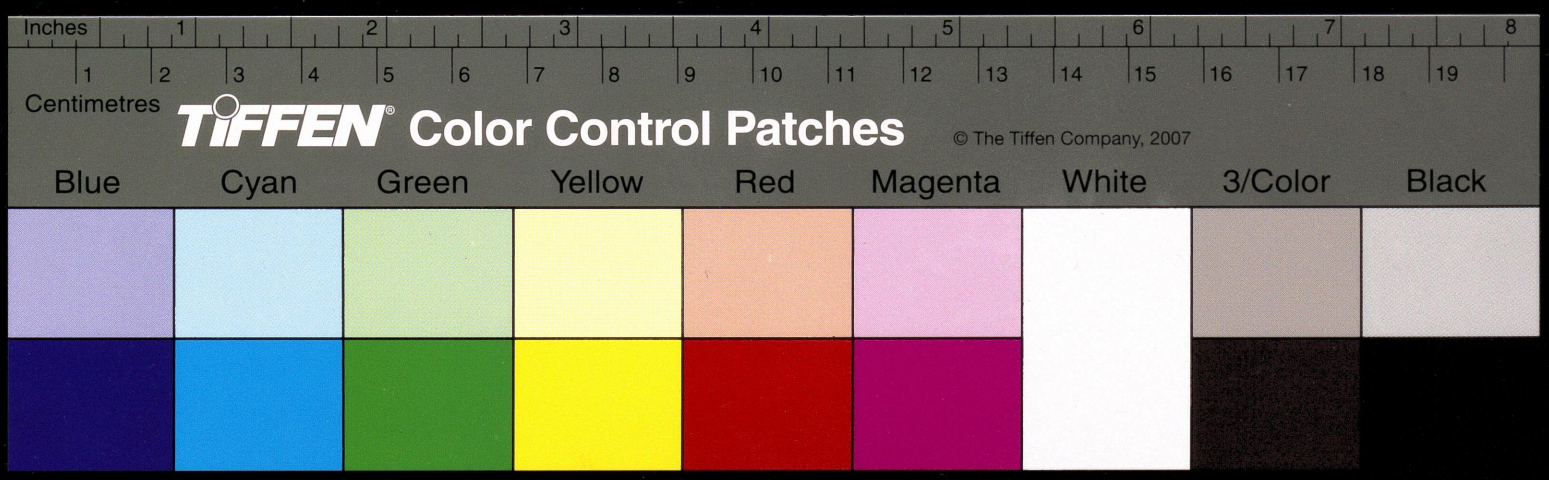
Amplifiers, oscillators including multi-vibrators, Trigger circuits, electronic counters.

(e) Statistic and probability theory

Random experiments, operation on event, probability, testing of hypothesis, random variables, measure of central tendencies and dispersion, mathematical expectation, regression, probability theory, probability distributions.

(f) Numerical analysis

Divided and central differences, interpolation, numerical solutions of algebraic and sytem of linear algebraic equations, numerical differentation and integration, numerical solutions of ordinary differential equations.



(g) Hydrodynamic principles

Density laws in isothermal and adiabatic atmosphere, review of laws for control volumes, conservation of mass, momentum and energy, elements of irrotational theory, some exact solutions of NS equations, introduction to boundary layer theory, turbulent flows and Reynold equations, one dimensional compressible fluid flows.

(h) Computer programming

Elementary exposition of computer architecture, number systems and codes, algonithms and charts, machine language programming, compilers and operating systems, constants and variables, arithmetic and logical operations, I/O operations, control statements, DO loops, subroutines, introduction to higher level languages.

(i) Calculus of variations

Concept of maxima and minima of functions, Langrange multipliers, Euler equations for functionals of various types, applications to problems of mechanics, elasticity etc. Garlekin and Rayleigh-Ritz method.

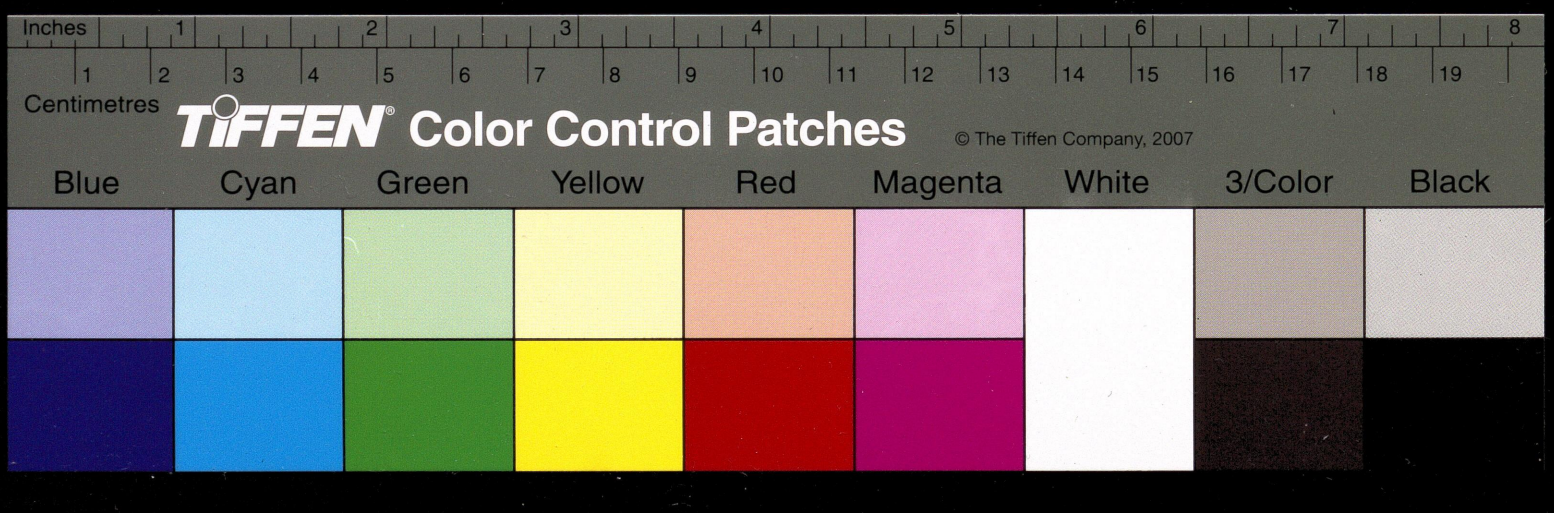
Note - Five lectures will be delivered by the library science section on ballistic biblioview.

2. Internal Ballistics

Combustion, burning of propellant, Vielle's law, form function, systems of internal ballistic equations, effects of variations, similarity relations, recoilless systems.

Nozzle flow theory, gas generation in the rocket motor, pressure in a rocket and the desirable characteristics of rocket propellants, geometrical configurations currently in use for boost and sustainer motors including dual thrusts motors.

Practical assignments.



3. Free Flight Dynamics I

Dynamics of rotating frames, ballistic reference frames, aerodynamic force system of clean and finned bodies, general equations of motion.

Angular motion of spinning and inertia stabilised bodies, normal equations and their solutions, motion of a rocket during burning phase, underwater motion, motion of ffee fall bodies, numerical methods of ballistic trajectory calc lations, drift and dispersion of spinning and finned bodies, differential corrections due to variations in initial conditions, secondary aerodynamic forces or meteorological conditions.

Practical assignments.

4. Experimental Techniques and Instrumentation

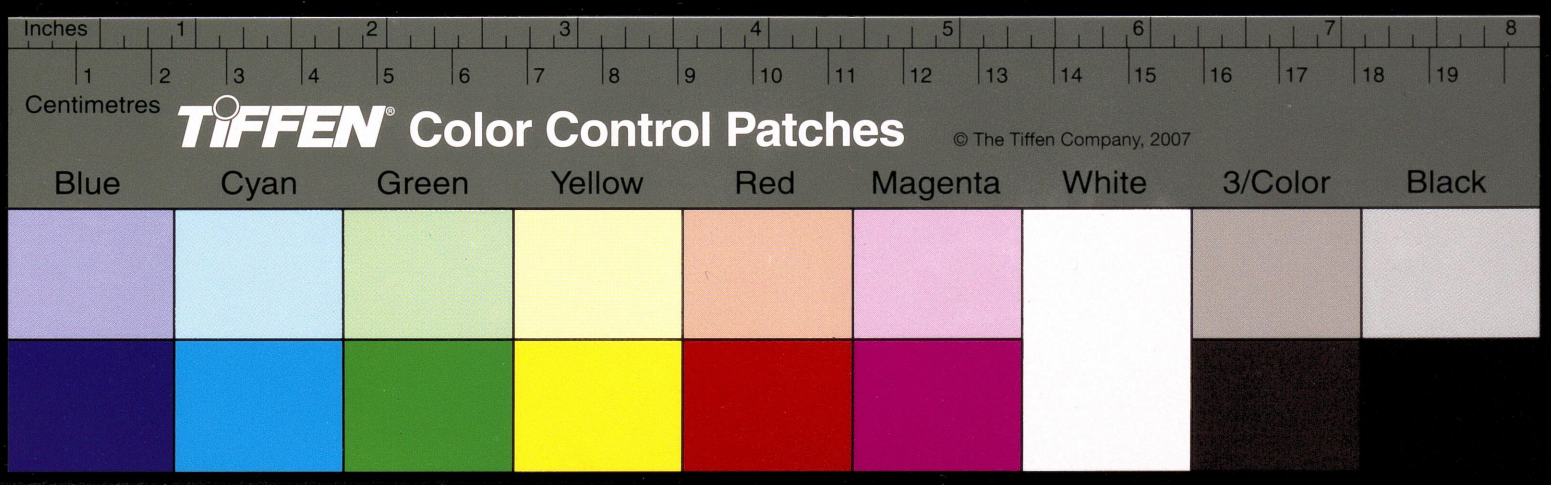
(a) Techniques

Introduction to types of measurements, initial velocity, angular deviations and angular velocity measurement techniques, drag determination methods, methods of parametric variations in aerodynamic force system measurements, analysis of mean area effect, compilation and reduction to standard conditions of the range data.

(b) Instrumentation

Velocity and pressure measuring instruments, instruments for temperature, delay, height of a point along trajectory, point of fall determination by optical instruments, strain measurement instruments, high speed photography, framing and streak cameras, flight test instrumentation, yaw sonde, transducer's for shock and blast determination.

Practical work.



5. Detonics and Terminal Effects

Propogation of a disturbance in a medium, Hugoniot curve, Jouguat's rule, Raleight processes, ideal detonation and applications, high velocity impact phenomena, jet penetration, scabbing.

Fragmentation theory and lethality, ricochet, wound ballistics.

6. Free Flight Dynamics II

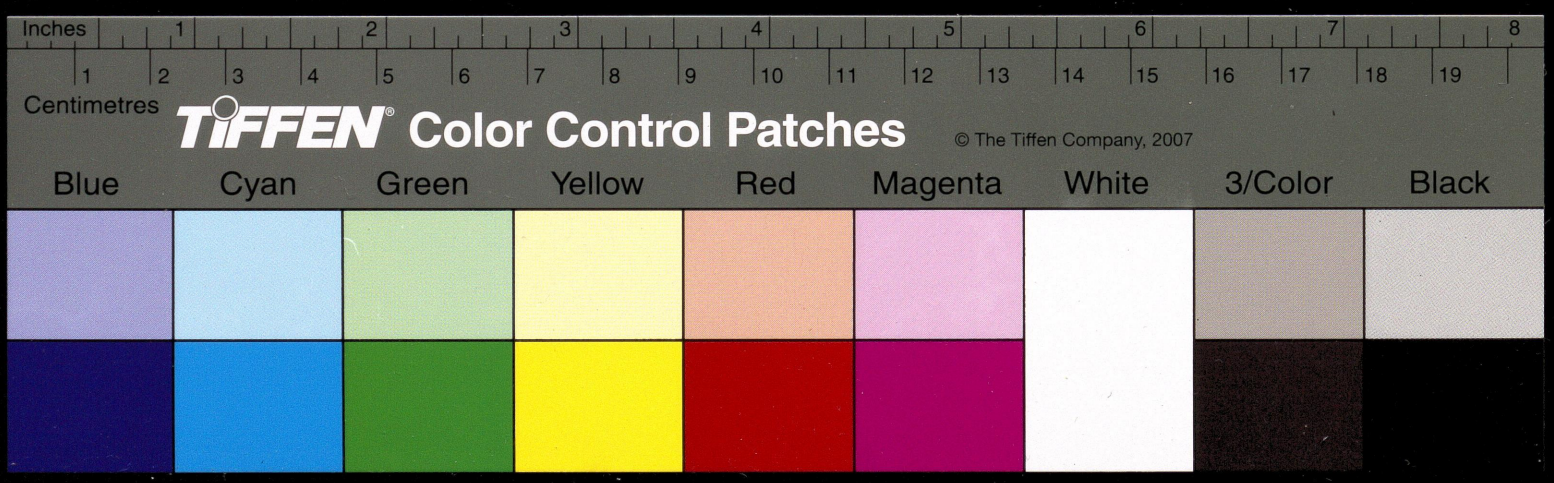
Dynamics of launch vehicles and ballistic missiles, optimal staging, central force motion, determination of orbital elements, orbital transfer and randezvour, station keeping, analysis of satellite attitude, orbital perturbations, optimisation of flight trajectories and life time of satellites.

7. Seminar

Each student would deliver two seminar lectures of one and half hour each. One topic will be directly connected to his dissertation/project work. Other would be on any allied topic given by the guiding teacher.

8. Dissertation/Design Project

Each student will be allotted a dissertation/design project by a guiding teacher. It will cover the review of earlier work and in depth study of the topic. It will include applied research/ design by the student.



MISCELLANY

A. ACADEMIC STAFF

* Prof P.C.Rath, M.A.(Maths).
Chairman Applied Mathematics Faculty
Field - Nonlinear Mechanics
Exterior Ballistics.

* Prof C.D.Ghildyal, Ph.D.
Head of Applied Maths Deptt.
Field - Fluid mechanics, Heat transfer in fluids, Internal ballistics of guns and rockets, Missile kinematics.

* Prof K.C.Sharma, Ph.D.
Head of Ballistics Deptt.
Field - Free flight dynamics,
Stability theory
Terminal effects.

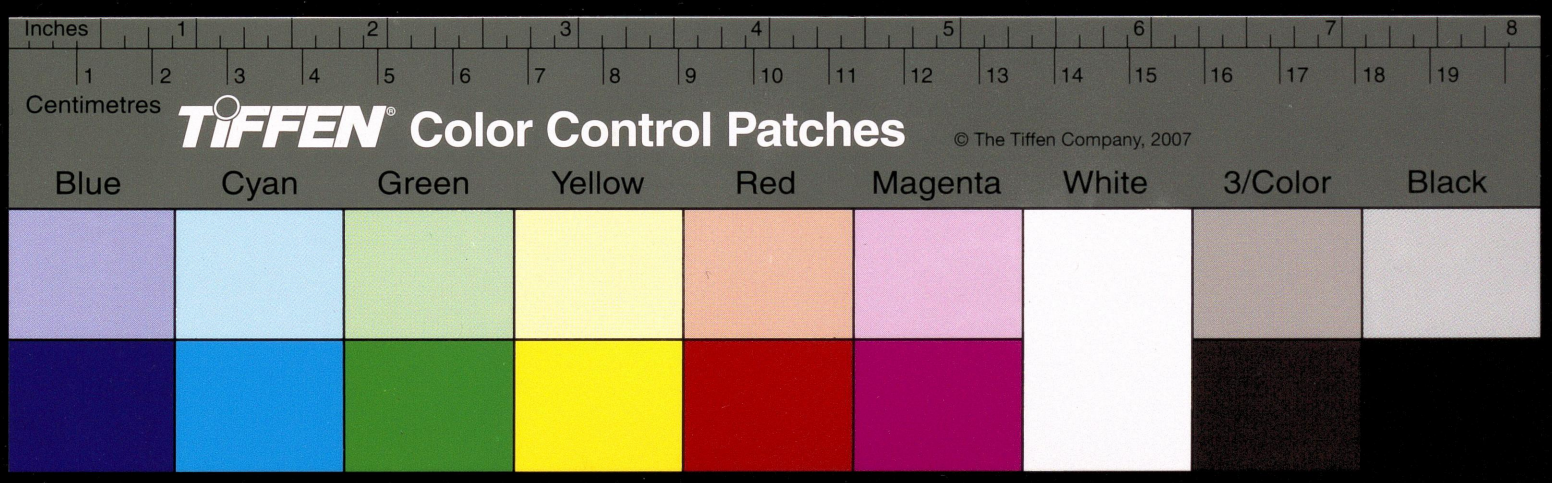
* Prof A.K.Govil, Ph.D.
Head of Statistics and O.R. Deptt.
Field - Reliability analysis.

Prof R.H.Dani, M.Sc.
Head of Ballistic Instrumentation Group.
Field - High speed photography.
Optoelectronic equipment design.

Prof K.V.Rao, M.Sc.
Field - Optimisation and optical control theory.

Note 1 Teachers marked * are recognised by the University of Poona for Ph.D. programmes.

2 Specialised and qualified teaching staff is also available in aronautics, propulsion, thermo-chemistry, electronics, metallurgy, guided and unguided weapon system in this Institute.



B. INFORMATION RESOURCES

The library of the Institute is well equipped with about 20,000 books, 350 journals and about 5000 reports. Collection on ballistics is comprensive and upto date. Collection also includes audio tapes and micro documents. Inter library loan and reprographic facilities are available.

Directing Staff

Shri G.J.Narayana, M.Lib.Sc.
Head Library and Documentation.

Shri H.G.Desai, B.Sc.
Librarian.

Resource Publications

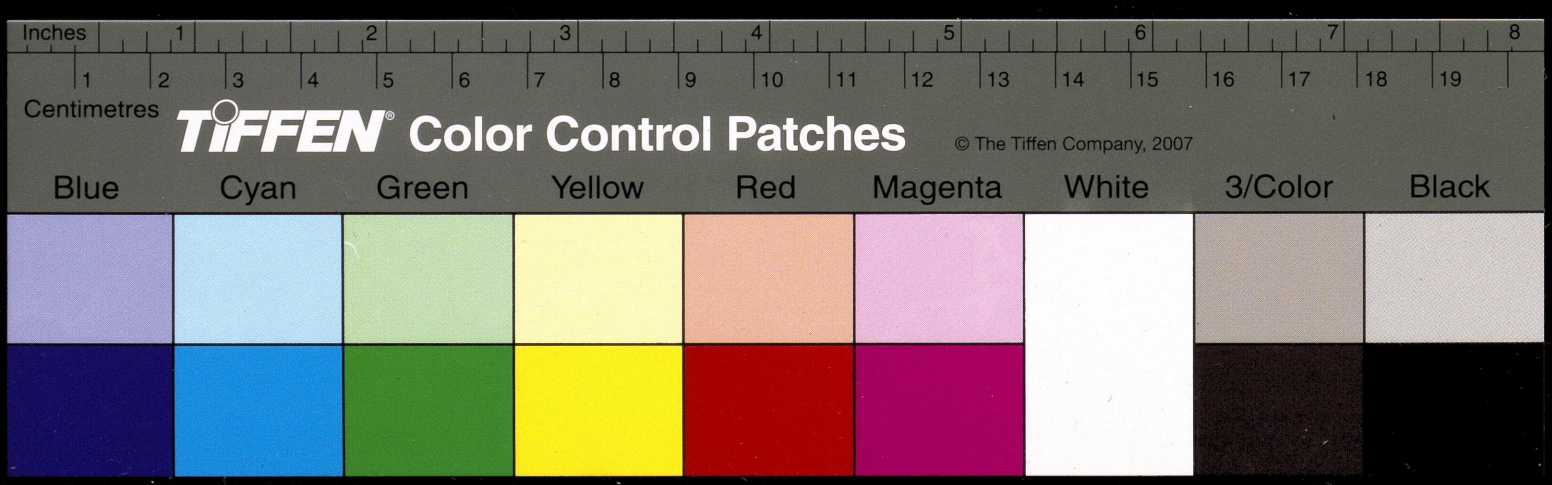
1. Ballistics A biblioview (Ballistics information and its organisation for retrieval) By G.J.Narayana.
2. Ballistics A bibliography (A classified collection of about 2000 references) by H.G.Desai.
3. Ballistics literature-I. reports (An index to reports available in defence R and D establishments) by H.G.Desai.
4. Rockets and Missiles - A select bibliography by H.G.Desai.

C. EXPERIMENTAL FACILITIES

The ballistic instrumentation laboratory is fully equipped for high speed camera, electronic cometers, opto-electronic equipments, thrust and pressure recording facilities, water tank for entry and subsequent motion, Static range facilities.

Wind tunnel, propulsion facilities are available in the Institute.

Additional facilities will be made use of from the sister organisations.



SYL/AM/

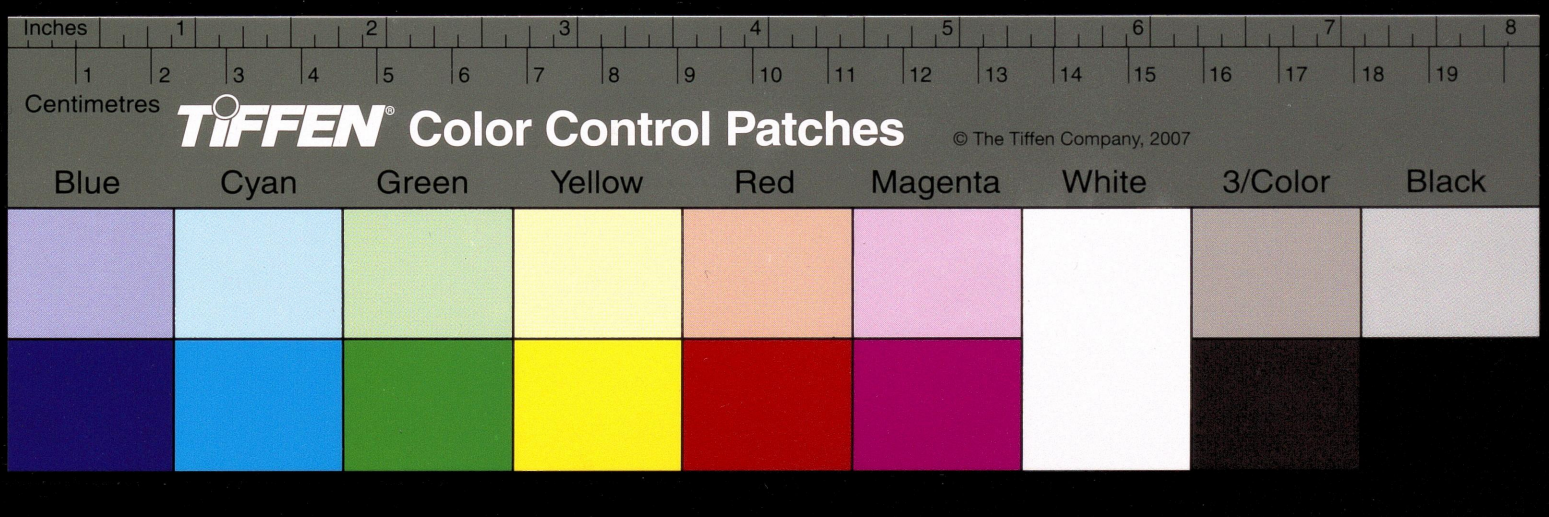
Date .....

Institute of Armament Technology

Girinagar, Pune-411 025

A CASE FOR INTRODUCING
A POST GRADUATE DIPLOMA COURSE
IN
BALLISTICS

Ballistics Deptt.
(A.M. FACULTY)



A POST GRADUATE DIPLOMA COURSE IN BALLISTICS

Section I

Aim

The aim of the post graduate diploma course in ballistics PGDC(Ballistics) is

a) to create potential in DRDO, DGI, Military Services for carrying out work in applied ballistics and astroballistics.

b) to enhance the capability and add to understanding of theoretical ballistics, experimental techniques and instrumentation to take up research and development work.

c) to render assistance by way of this training to scientists in space commission and other autonomous bodies in the country.

d) to create awareness among post graduate students to take up research and development work in this field.

e) to train students from foreign countries.

Eligibility

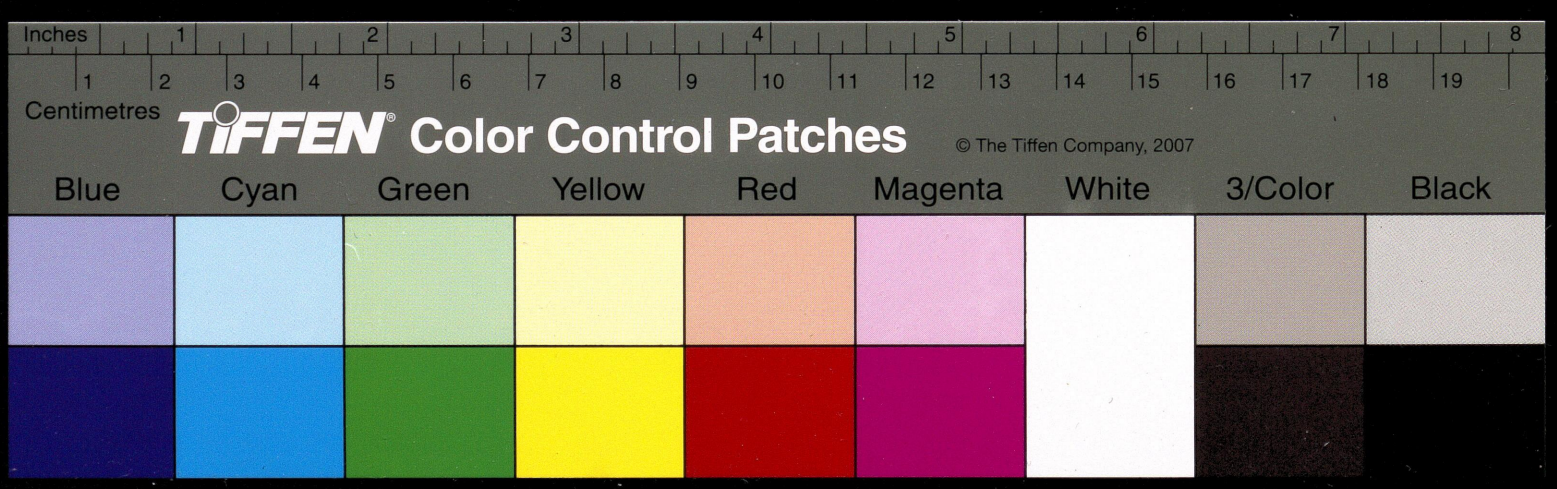
2. The candidates, selected by Institute of Armament Technology, will be either M.Sc.(Maths), M.Sc.(Physics), B.E.(Mech) or B.E.(Aeronautical) with a good academic record.

3. The course is open to serving military officers, scientists from R and D, DGI, Ordnance Factory Services and other scientists under ministry of defence production.

4. Two to three seats in the course may be given to other civil organisations such as space commission, CSIR and Forensic Laboratories on their request.

5. Two seats will be filled by an open advertisement.

6. Candidates from friendly foreign countries may be admitted.



Conditions of Admission for Outsiders

7. The sponsoring organisations of the candidates in para 4 will pay a nominal fee of Rs.500/- to IAT for each candidate.

8. The candidates admitted through the open advertisements will be paid a scholorship of Rs.400/- p.m. by IAT for meeting their expenses towards maintenance etc. Each candidate will additionally get an ad-hoc grant of Rs.1500/- from IAT to meet the expeses on travel, books etc.,

9. Govt. of India is not bound, in any way, to provide employment to candidates selected through open advertisement on completion of the course.

10. Conditions of admissions for candidates from abroad will be decided by R and D HQ. The eligibility of admission, however, will be decided by IAT.

Capacity of the Course

11. Not exceeding 10 students per course.

Duration and Frequency

12. The course will be of 44 weeks duration, commencing from mid June. One course per year will be undertaken.

Method of Examination

13. The students have to meet the requisite standard in each paper/seminar/dissertation. The final assessment will be made on the aggregate of the internal assessment/theory papers/seminars/dissertation. The weightage in the examination will be as follows

a) Teaching subjects

Internal assessment(two testa and a viva).....40

Question paper 60

b) Seminars 100

c) Dissertation Equivalent to three teaching subjects.