

To

Smt. Smriti Z. Irani  
Hon. Minister for Human Resources  
Govt. Of India,  
Shastri Bhavan, New Delhi 110001

30<sup>th</sup> November 2015

Dear Ms. Irani

This is in connection with the revamp of the JEE examination, the Terms-of-Reference document and the report submitted by the committee led by Prof. Ashok Misra. I wish to submit my comments on the same. My focus will be on two items in the ToR and the 6 recommendations below.

#### **TOR**

*A. To recommend structure of a single exam that tests the understanding, conceptual clarity, and innovative thinking of students for admission to IITs and NITs.*

*B. To find means in the exam structure that would reduce the pressure on students and reduce dependence of students on the coaching centres, without diluting the quality of testing.*

The recommendations of the Misra committee as appearing on page 6-7 for the years beyond 2017 may be summarized as follows:

#### **Summary of Recommendations of Misra Committee**

- R1.** Formation of a National Testing Agency on the lines of ETS, an agency of the USA.
- R2.** Formulation and administration of of an aptitude test. Use of this test to select about 4 lakh students who will write the JEE for admission into IIT, NIT and CFTI system.
- R3.** No significant change in the content and mode of the JEE.
- R4.** More official test material from JEE office to counter coaching.
- R5.** Improvement in school curricula and pedagogy.
- R6.** Preparing a continuum of institutions from CFTIs to state government institutions and lower down to lower stress and reduce coaching.

My submission is as follows:

#### **Executive Summary.**

**A.** The current set of students who secure admission into the IITs has (i) gross inequities across gender, class and location, and (ii) doubtful interest in satisfying the mandate for the IITs and NITs,

i.e., engineering for national and regional needs.

**B.** The IITs are unable or uninterested in placing their graduates into engineering for Indian needs. This creates perverse incentives in the form of branding and a few high-paying jobs in the multi-national service, finance and consulting sector.

**C1.** This creates an aspirational dysfunction which is one important cause of the coaching problem.

**C2.** The second cause is the belief that a JEE like test along with the fantastic odds can actually test *understanding, conceptual clarity, and innovative thinking* or any attribute suitable for engineering. Such a test will largely test access to coaching.

**D.** The current set of proposals will largely leave all of this unchanged since most of the current set of students and serious aspirants will clear the aptitude test.

**E.** Assuming that the aptitude test is a qualifying test, it will do one important job. It will give a signal to about 70% of the applicant pool about their unsuitability for IIT/JEE. This will save them from further wasteful investments of time and money.

**F.** If R5 is to be implemented then it will mean interpreting *understanding, conceptual clarity, and innovative thinking* as a part of scientific temper, a subtle, important and cultural skill. The idea of a national ranking test will have to be discarded. A national qualifier test is at best what can be conceived.

**G.** If R6 is to be implemented, the reason for Item B above needs to be examined and addressed.

### **My procedural recommendations are:**

**A.** *Define state quotas for NITs and IITs* (what used to be done for the RECs two decades ago). This will bring a welcome balance across all states. It will also bring students from within the region to the NITs and IITs and who will be interested in regional issues. This will assist the state governments in utilizing the expertise of these institutions and will be the first step in R6.

**B.** *Allow each state to prepare its own merit list, using its state board exam, an entrance test or in any other way.* This will allow the state boards to adapt their science curricula to their regional needs, include say, training in scientific temper, and adapt testing methods to their curricula and pedagogy, and address equity issues within their state. It will be the first step in R5.

**C.** *NITs/IITs may have a **qualifier exam**.* Students who are admitted into the NITs and IITs and who come in from the state merit list, must pass this exam. This will ensure that the IITs and the NITs can maintain the standards that they choose.

This will fit the philosophy of cooperative federalism, the locality of technology, the importance scientific temper. Moreover, it will make available to the states, the participation of the IITs and NITs in the revamp of regional engineering.

### **Discussion**

#### **JEE, Aptitude test and rigorous analysis.**

1. Where exactly are the attributes of “*Understanding, conceptual clarity and innovative thinking*” to be tested? In the aptitude test? Or in the JEE? This should be clarified. A clear

set of attributes for both the JEE and the aptitude should be issued.

2. I assume that the aptitude test will be operated as a qualifier and not as a ranking exam. I assume that the conduct of the NTS will be sufficiently rigorous. It will state what attributes it aims to test and rigorously justify that those are what are being tested.
3. Unfortunately, such rigour has not developed in the IIT administered GATE and JEE (Advanced) exams. These *de facto* decide what high-school Science and engineering mean in this country without clearly stating what attributes it deems important. This situation should no longer be deemed tenable.

### **The JEE Test-Subject of Science, Process of Science and equitable outcomes**

4. What is actually tested in the current JEE are a limited set of skills in a time-bound objective-type test on a list of topics which fall under the Physics, Chemistry and Mathematics curricula of the Central Board of Secondary Education (CBSE).
5. The attributes of “*Understanding, conceptual clarity and innovative thinking*” of the ToR also fall under what may be called **scientific temper**. This is the **process of science**, such as the design and conduct of experiments, understanding causality, documentation and making arguments, as opposed to the **subject of science** such as *Biot-Savarts law, esterification* or the *equation of the parabola*. The JEE test at best, measures competence in the subject matter of Science.
6. Scientific temper is a delicate and cultural skill which is enshrined in our constitution. It is the key to the development of our citizens and their welfare. It includes the skills of careful use of natural resources, adoption of better practices and taking up scientific projects such as fixing the village water supply system or experimenting with *chulhas*.
7. Training of these skills is best done by regional and local role-models and using the resources and phenomena of the **vicinity as the subject of study**. The responsibility of such training falls under the ambit of the school education boards of various states. Moreover, with correct training, these skills are **equally available over gender, caste, class and location**.
8. The outcomes of the JEE contradict this essential equality (see Tables 2,3). In particular, see Table 4, where we see that girl students perform much better in the CBSE Board Exams at all levels, on a very similar curricula on a more comprehensive and fairer test corrected by human checkers.
9. As far as is known, scientific temper cannot be tested *with reasonable confidence* in an objective type test spanning 6 hours where there is no human contact and familiarity of the tester with the student. **What is the proof** that the JEE actually tests scientific temper or for that matter, “*Understanding, conceptual clarity and innovative thinking*”?
10. Coming to the subject matter of Science, the format and the odds of the exam make it very hard to meaningfully test conceptual understanding of the subject. Many questions must be posed in an idealized world, far removed from real science or an artificial conjunction of concepts. Real science is far more empirical and nuanced. Some example questions appear in the Appendix. The first question is about nuclear plants for villages which is far removed from reality and would actually confuse a rural student. The second question is about the colour of sulfide salts which is purely rote-work. The third is about a particle in an electric

field generated by electric wires. The problem is wrong as posed but has a formulaic “correct” answer. All questions are highly susceptible to coaching and far from testing “*Understanding, conceptual clarity and innovative thinking*” in the subject matter of science.

### **MCQ exam, coachability and suitability for engineering.**

11. The typical JEE(Advanced) has about 120 objective-type questions to be solved in 360 minutes. Such a situation rarely happens in real-life engineering or science where careful design and analysis must be made and there may be several correct answers. Time and speed is of the least essence while a correct understanding of the situation and considerations of safety and utility are of most concern. It is unclear what is being tested and what will be the quality of students who come out at the top 5%-10% of such a test. **What is the proof** that such students are better prepared to do real engineering? In fact, the placement records (see Table 1) of the IIT Bombay show that the best pay-masters to these graduates are not Indian engineering companies but actually international finance, IT and consultancy companies which have may some use for fast quantitative skills.
12. What this test does reward are skills at the selection of questions to be solved, an earlier experience with multiple-choice questions, peer groups with similar interests in competitive examinations etc., i.e., facilities which are best provided by coaching classes and not schools. This is actually seen by the skew in the gender and location of students admitted to the IITs. This is also seen in the great inequality (see Table 5) on expenditure made by households across states, location and across gender. Thus the JEE may be testing access to coaching much more than ability in the process of science or suitability of engineering.
13. Given 8-12 above, the JEE system may be propagating the already-existing inequality in our society. **What is the proof** that the proposed examination is less amenable to coaching? Many of the above points have been raised by the Ramasamy Committee as well. Also see pg. 5 of Annexure II of the Misra Committee report.

### **CBSE curriculum, state curricula, balance and the constitution.**

14. Data shows that more than 50% of students at the IIT come from CBSE. The committee should ponder on the severe inequality in the representation across state boards and its impact on state government curricula for XIIth. Many state boards are trying to match the CBSE curricula which is largely irrelevant for students from their own state. How can R5 be achieved when the the JEE so substantially disrupts and distorts the state's conduct of its school curricula?
15. CBSE serves a largely urban student body with a large fraction whose parents are professionals. Moreover, the IIT JEE curriculum is closest to the CBSE curriculum. Shockingly, the rationale for the CBSE curriculum, e.g., Physics XI-XII is to become “competent to meet the challenges of academic and professional courses” and “to compare with international standards” rather than to teach students to analyse their vicinity. This is evident from the fact that groundwater or water quality is absent but highly mathematical formulations of the Gauss's law in Physics or the abstruse Riemer-Tieman reaction in Chemistry are present. State boards would be ill-advised to copy such a curriculum. However, many state boards are under pressure to match the “quality” of CBSE thereby ignoring the training in scientific temperament and regionally relevant subject material that a typical student would need in his/her daily life.

16. Ideally, **should not the design of the admission process be such that state board students have an equal chance of getting into IIT as a CBSE student?** What steps have been taken to ensure this? If not, this is a direct infringement of the spirit behind Education being in the concurrent list, where only 63-66 of the Center's list are to be used to guide the involvement of the center in school education. Item 66 refers to general technical education where the role of the center is to maintain standards and not to rank students for admission into centrally sponsored institutions. This violates the *original intent* of putting Education in the state list, as was pointed out by the states of West Bengal, Punjab and Tamil Nadu in 1976.
17. This imbalance also leads to the absurd situation that there are only 5 student from Himachal Pradesh in IIT Mandi. What would be the motivation of IIT Mandi to work for the hill states and how will it find students to work on the agenda?

I must thank you for your attention.

Regards,

Milind Sohoni  
Professor, CSE and CTARA

CC:  
Secretary, Higher and Technical Education, Government of Maharashtra.  
Hon. Minister for Education, Government of Maharashtra.

## Tables.

**Table 1.** Starting jobs by sectors for IIT Bombay graduates in 2013.

GG refers to global company serving a global market (e.g., Bank America or General Electric), while II refers to an Indian company serving Indian markets (e.g., Ambuja Cement or Tata Motors). IG and GI are similarly explained (e.g., Infosys and Hindustan Unilever respectively). Super-GG are placements abroad. The number, e.g., 116 (7.9) indicates the number placed and the average annual salary in Rs. Lakhs.

Placements IIT Bombay 2013				
Sector	Engineering	Finance	Consulting	IT
Super-GG	25 (27.7)	10 (35.0)	7 (54.0)	42 (51.3)
GG	116 (7.9)	82 (11.7)	110 (9.6)	102 (10.0)
IG	54 (6.5)	19 (7.2)	11(5.8)	28 (7.2)
GI	24 (9.3)	10 (14.2)	10 (5.2)	5 (9.3)
II	64 (6.5)	13 (9.5)	8 (5.8)	22 (7.9)

**Table 2.** Statistics of students appearing for and qualifying for entrance to the IITs by gender.

	JEE 2012			JEE (Advanced) 2013		
	Appeared	Qualified	Pass %-age	Appeared	Qualified	Pass %-age
Boys	337916	21226	6.28	103660	18468	17.8
Girls	168568	2886	1.71	23089	2366	10.2
%-age of Girls	33.2	11.9	-	18.2	11.4	-

**Table 3.** Statistics of students appearing for and qualifying for entrance to the IITs by place of passing XIIth standard.

Cohort	JEE 2011		JEE 2012		JEE (Advanced) 2014	
	Registered	Qualified	Registered	Qualified	Registered	Qualified
Village	19%	10%	19%	11%	13%	10%
Town	29%	25%	29%	26%	19%	14%
City	52%	65%	52%	63%	68%	76%

**Table 4.** CBSE 2013 Standard XIIth statistics by gender.

CBSE 2013 Statistics.							
	Appeared	Secured marks	90%	%-age of total	Secured marks	95%	%-age of total
Boys	512210	22596		4.4	2855		0.56
Girls	376410	22053		5.8	3237		0.86
%-age of Girls	42.4	49.3		-	53.1		-

**Table 5.** Average household spending on education by families having one studying member (our analysis of 68th round, NSSO, 2012).

		Andhra Pradesh Urban	Andhra Pradesh Rural	Rajasthan Urban	Rajasthan Rural	Odisha Urban	Odisha Rural	Tamil Nadu Urban	Tamil Nadu Rural
Households with one studying male	Mean (Rs.)	9919	5706	19096	4362	5765	1787	11046	8493
	Number of Samples	365	373	235	263	143	291	373	293
	Gini	0.61	0.58	0.56	0.64	0.65	0.70	0.64	0.67
Households with one studying female	Mean (Rs.)	9233	3752	9369	3431	4278	2292	12653	6949
	Number of samples	281	245	98	126	94	191	321	259
	Gini	0.61	0.55	0.60	0.56	0.82	0.76	0.65	0.69

**Appendix.** Some sample questions from JEE Advanced.

1. JEE Advanced 2015: Question 6, Paper 1.

A nuclear power plant supplying electrical power to a village uses a radioactive material of half life  $T$  years as the fuel. The amount of fuel at the beginning is such that the total power requirement of the village is 12.5% of the electrical power available from the plant at that time. If the plant is able to meet the total power needs of the village for a maximum period of  $nT$  year, then the value of  $n$  is: (suggested correct answer is 3).

**Comment:** Completely unreal. Question setter unaware of rural electricity and nuclear plants. Question will confuse rural student and reward false conceptualization.

2. JEEAdvanced 2014: Question 33, Paper 1, Code 1.

Among  $PbS$ ,  $CuS$ ,  $HgS$ ,  $MnS$ ,  $Ag_2S$ ,  $NiS$ ,  $CoS$ ,  $Bi_2S_3$  and  $SnS_2$ , the total number of BLACK coloured sulfides is: (Suggested correct answers are 5 and 6).

**Comment:** Rote-work. Expects students to have seen these in their school laboratories?

3. JEE Advanced 2014: Question 14, Paper 1, Code 1.

Two parallel wires in the plane of the paper are distance  $X_0$  apart. A point charge is moving with speed  $u$  between the wires in the same plane at a distance  $X_1$  from one of the wires. When the wires carry current of magnitude  $I$  in the same direction, the radius of curvature of the path of the point charge is  $R_1$ . In contrast, if the currents  $I$  in the two wires have directions opposite to each other, the radius of curvature of the path is  $R_2$ . If  $X_0/X_1=3$  then the value of  $R_1/R_2$  is? (suggested correct answer is 3).

**Comment:** Question is wrong. In the magnetic field around a wire, the field is not constant but varies with distance from the wire. Standard formula is not applicable.